Total Maximum Daily Load

for

South Grand River
Cass and Henry Counties

303(d) Listing: *Escherichia coli* Bacteria

Submitted: Dec. 27, 2021
Approved: June 1, 2022

Prepared by: Water Protection Program, Watershed Protection Section

WATER BODY SUMMARY
Total Maximum Daily Loads (TMDL) for South Grand River
303(d) Listing: *Escherichia coli (E. coli)* Bacteria

Water Body:
South Grand River

Location:
Cass and Henry Counties


Location of watershed

TMDL Development Priority:
High

8-digit Hydrologic Unit Code (HUC):[1]
10290108 – South Grand

12-digit HUC Subwatersheds:
See Section 2

Water Body Identifications (WBIDs) and Hydrologic Class:[2]
1249 - Class P

Designated Uses:[3]
Irrigation
Livestock and wildlife protection
Human health protection
Warm water habitat (aquatic life)
Whole body contact recreation category B
Secondary contact recreation

Impaired Use:
Whole body contact recreation category B

Pollutant Identified on the 2020 303(d) List:
Escherichia coli (E. coli) (fecal indicator bacteria)

Identified Sources on the 2020 303(d) List:
Rural nonpoint sources

Length and Location of Impaired Segments:
66.8 miles, from mouth to Section 02, Township 44N, Range 33W

---

[1] Watersheds are delineated by the U.S. Geological Survey using a nationwide system based on surface hydrologic features. This system divides the country into 2,270 8-digit hydrologic units (USGS 2019). A hydrologic unit is a drainage area delineated to nest in a multilevel, hierarchical drainage system. A hydrologic unit code is the numerical identifier of a specific hydrologic unit consisting of a 2-digit sequence for each specific level within the delineation hierarchy (FGDC 2003).

[2] For hydrologic classes see 10 CSR 20-7.031(1)(F). Class P streams maintain permanent flow even in drought periods.

[3] For designated uses see 10 CSR 20-7.031(1)(C) and 10 CSR 20-7.031 Table H. Presumed uses are assigned per 10 CSR 20-7.031(2)(A) and (B) and are reflected in the Missouri Use Designation Dataset described at 10 CSR 20-7.031(2)(E).

Table of Contents

Figures

Tables

1. Introduction

In accordance with Section 303(d) of the federal Clean Water Act, the Missouri Department of Natural Resources is establishing a total maximum daily load (TMDL) to address elevated concentrations of *Escherichia coli* (*E. coli*) bacteria in South Grand River in Cass and Henry counties. This TMDL report addresses a water quality limited segment included on Missouri's 2020 303(d) List of Impaired Waters due to exceedances of Missouri's *E. coli* bacteria criterion.[4] This listing was approved by the U.S. Environmental Protection Agency (EPA) on November 30, 2020.[5]

Section 303(d) of the federal Clean Water Act and Title 40 of the Code of Federal Regulations (CFR) Part 130 require states to develop TMDLs for waters that do not meet applicable water quality standards. Missouri's Water Quality Standards at Title 10 of the Code of State Regulations (CSR) Division 20 Chapter 7, Rule .031 consist of three major components: designated uses, water quality criteria to protect those uses, and an antidegradation policy. A TMDL is equal to the loading capacity of a water body for a specific pollutant and represents the maximum amount of a pollutant that a water body can assimilate and still attain and maintain water quality standards. The *E. coli* bacteria loading capacities for each water body are derived from the maximum *E. coli* concentration allowed by Missouri's Water Quality Standards and are translated to mass loads using stream flow under all recorded conditions. Once the loading capacity of a water body has been quantified, existing and future point sources and nonpoint sources are assessed for their potential to contribute the pollutants of concern. In accordance with 40 CFR 130.2, contributing point sources are assigned a portion of the available loading capacity as a wasteload allocation and nonpoint sources are assigned a load allocation. In accordance with federal Clean Water Act section 303(d)(1)(C), a margin of safety is also included. Margins of safety can be explicit (numeric) or implicit (qualitative) to account for any lack of knowledge concerning the relationship between pollutant loading and water quality, uncertainty associated with the model assumptions, or data inadequacies (40 CFR 130.7). The TMDL for each pollutant is the sum of the wasteload allocation, the load allocation, and the margin of safety.

2. Watershed Description

South Grand River water body identification (WBID) 1249 is located in west Missouri south of the Kansas City area within the South Grand subbasin, which is cataloged by the U.S. Geological Survey (USGS) as the 8-digit hydrologic unit code (HUC) 10290108. South Grand River is formed by the confluence of Massey Creek and East Creek approximately five miles southwest of Peculiar. The river flows southeast for 66.8 miles and enters Harry S. Truman Reservoir near Clinton. The South Grand River watershed is composed of 32, 12-digit HUC subwatersheds totaling 1,316 square miles as displayed in Figure 1 and listed in Table 1. Approximately 29 square miles of the South Grand River watershed are located in Kansas.

[4] A water quality limited segment is any segment where it is known that water quality does not meet applicable water quality standards, or is not expected to meet applicable water quality standards, even after the application of the technology-based effluent limitations required by sections 301(b) and 306 of the federal Clean Water Act (40 CFR 130.2).

[5] The Department maintains current and past 303(d) lists and corresponding assessment worksheets online at dnr.mo.gov/water/what-were-doing/water-planning/quality-standards-impaired-waters-total-maximum-daily-loads/impaired-waters.

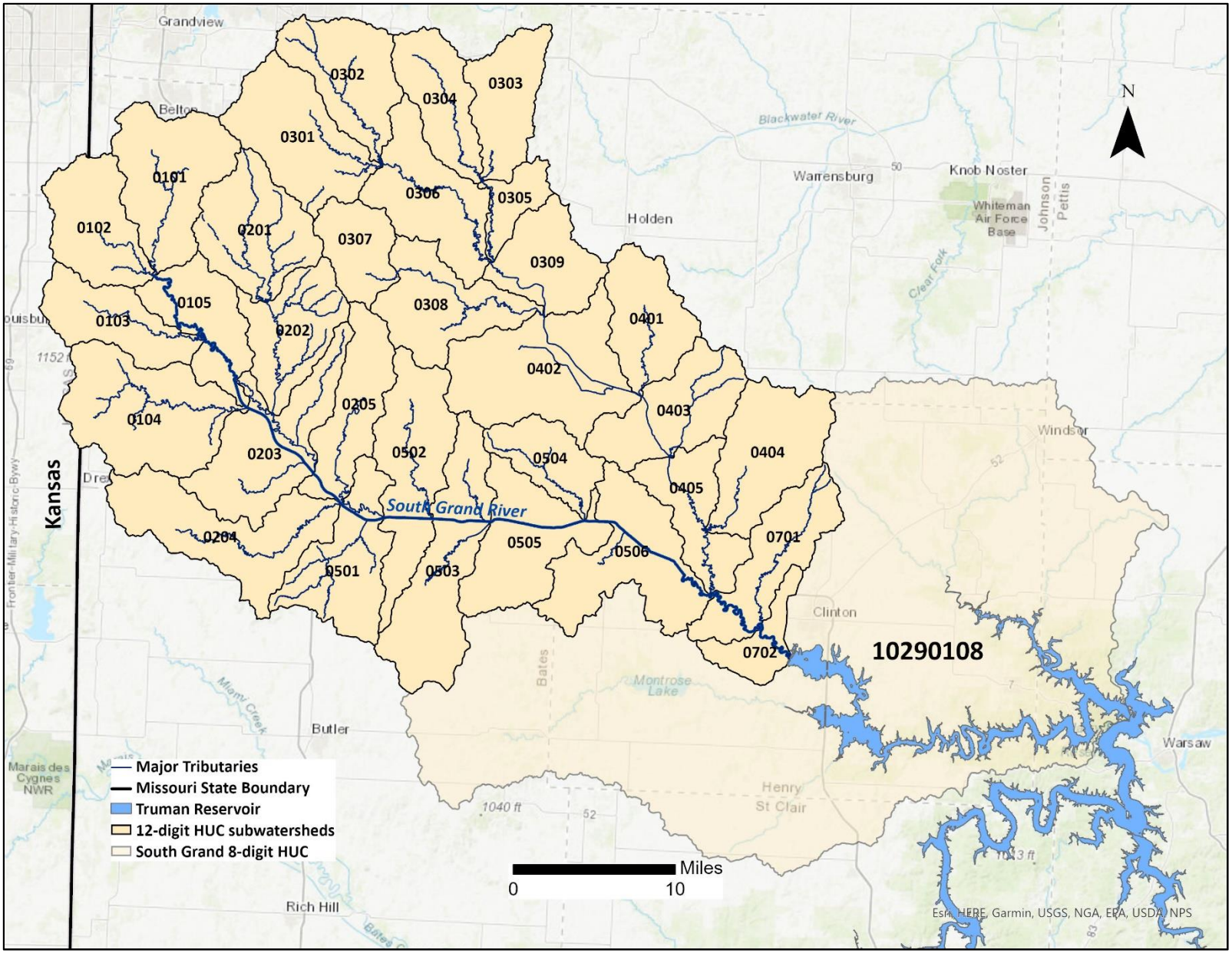

Figure 1. South Grand River 12-digit HUC Subwatersheds

Table 1. 12-digit HUC Subwatersheds within the South Grand 8-digit HUC 10290108

Last 4 Digits	Name	Last 4 Digits	Name
0101	East Creek	0307	Headwaters Camp Branch
0102	Massey Creek	0308	Camp Branch
0103	Poney Creek	0309	Lost Creek-Big Creek
0104	South Fork South Grand River	0401	Bear Creek
0105	Adams Branch-South Grand River	0402	Panther Creek-Big Creek
0201	Headwaters East Branch South Grand River	0403	Norris Creek-Big Creek
0202	East Branch South Grand River	0404	Honey Creek
0203	Black Creek-South Grand River	0405	Big Creek
0204	Morman Fork	0501	Big Deer Creek-South Grand River
0205	Eightmile Creek-South Grand River	0502	Sugar Creek-South Grand River
0301	Middle Big Creek	0503	Elk Fork-South Grand River
0302	Headwaters Big Creek	0504	Knob Creek
0303	East Branch Crawford Creek	0505	Cove Creek-South Grand River
0304	West Branch Crawford Creek	0506	White Oak Creek-South Grand River
0305	Crawford Creek	0701	Fields Creek-South Grand River
0306	Duncan Branch-Big Creek	0702	Town Creek-South Grand River

2.1 Geology, Physiography, and Soils

South Grand River is located within the Osage/South Grand ecological drainage unit, which is located in eastern Kansas and west central Missouri (MoRAP 2005). Ecological drainage units are groups of watersheds that have similar biota, geography, and climate characteristics (USGS 2009). Within the South Grand ecological drainage unit, the South Grand River watershed is located in the Wooded Osage Plains EPA Level IV ecoregion (ecological subsection). Ecoregions are areas with similar ecosystems and environmental resources and are designed to serve as a spatial framework for the research, assessment, management, and monitoring of ecosystems and ecosystem components. By recognizing spatial differences in ecosystems, ecoregions stratify the environment by its probable response to disturbance (Chapman et al. 2002). Ecoregions are further defined in Missouri's Water Quality Standards at 10 CSR 20-7.031(1)(H).

The Wooded Osage Plains ecoregion is an undulating plain with smooth, low, limestone escarpments and small areas of exposed bedrock (Chapman et al. 2002). Underlying geology consists of alternating beds of limestone, sandstone, shale, and coal. The sandstone and shale impede downward water movement, which results in few aquifers and streams that are surface water dominated. Most streams are ephemeral or intermittent. Stream channels are highly meandering with very low gradients. Waters are generally turbid, and stream beds are dominated by sand and silt with few poorly defined riffles (MoRAP 2005).

Soils are categorized into hydrologic soil groups based on similar runoff potentials. Each hydrologic soil group indicates the rate at which water enters the soil profile under conditions of a bare, thoroughly wetted soil surface (NRCS 2009). This infiltration rate determines the quantity of precipitation that flows over land to water bodies as direct runoff. Group A soils have the highest rate of infiltration and the lowest runoff potential. Group D soils have the lowest rate of infiltration and highest runoff potential. Many wet soils fall into dual soil groups (e.g., Group C/D) due to the presence of a seasonal high water table that results in saturation to the soil surface. Dual hydrologic soil groups account for this condition by providing both the drained and undrained condition of the

soil.[6] Soils that are "not rated" include areas of open water, barren lands, mining areas, and some urban areas. It should be noted that soil runoff potential is only one factor that determines the volume of runoff in a watershed. Impervious surfaces, vegetative cover, slope, rainfall intensity, and land use can significantly influence the potential for runoff regardless of the characteristics of the underlying soil. Table 2 provides a summary of the hydrologic soil groups by area in square miles and relative percent. Figure 2 shows the distribution of hydrologic soil groups in the South Grand River watershed.

Table 2. Hydrologic Soil Groups in the South Grand River Watershed (NRCS 2020)

Hydrologic Soil Group	Area in the Watershed	
	Square miles	Percent
Group A	0.4	0.03%
Group B	11.9	0.93%
Group B/D	32.9	2.55%
Group C	353.3	27.46%
Dual Group C/D	285.6	22.19%
Group D	587.8	45.68%
Not Rated	14.8	1.15%
Total[7]	1,286.6	100.0%

[6] For the purpose of hydrologic soil group, adequately drained means that the seasonal high water table is kept at least 24 inches (60 centimeters) below the surface in a soil where it would be higher in a natural state (NRCS 2009).

[7] Hydrologic soil group data is presented for Missouri only. Approximately 30 square miles of the watershed is in Kansas and is not counted here.

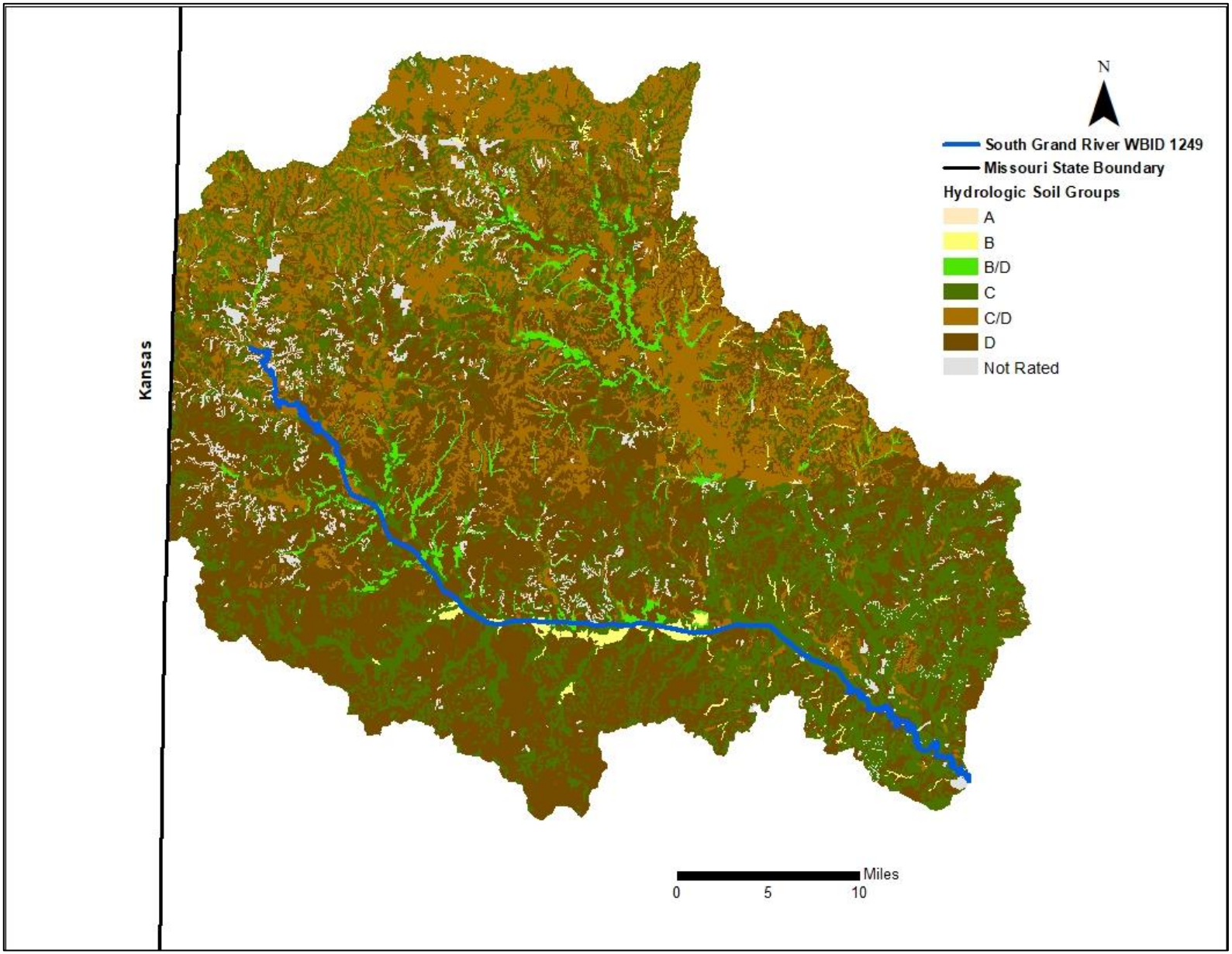

Figure 2. Hydrologic Soil Groups in the South Grand River Watershed

2.2 Climate

The most recent climate data from a weather station in close proximity to South Grand River were measured at the National Centers for Environmental Information Lee's Summit Municipal Airport Weather Station (USW00053879). The climate normals were developed based on temperature and precipitation data collected at that station between 1991 and 2020 (NOAA 2020). Precipitation normals are especially important because they relate to stream flow and runoff events that influence pollutant loading. Table 3 presents the 30-year monthly climate normals from the Lee's Summit Municipal Airport Weather Station for precipitation and temperature. Figure 3 displays the data.

Table 3. 30-year Monthly Climate Normals at the Lee's Summit Weather Station

Month	Precipitation Total	Minimum Temperature	Maximum Temperature
	in	ºF	ºF
January	0.96	22.1	39.0
February	1.43	25.9	44.3
March	2.14	35.4	55.4
April	4.19	45.5	65.5
May	5.70	55.9	74.8
June	4.95	65.4	84.0
July	4.57	69.7	88.3
August	4.54	67.6	86.9
September	3.07	59.0	79.0
October	3.39	47.2	67.1
November	2.05	36.2	54.0
December	1.35	26.3	43.2
	Total	**Average**	**Average**
	38.34	46.4	65.1

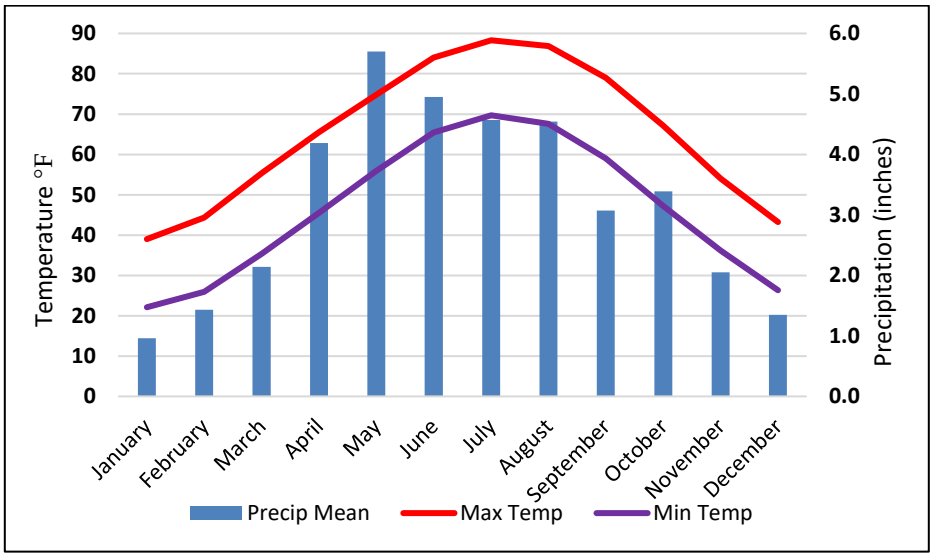

Figure 3. Monthly Climate Normals – Lee's Summit, MO

2.3 Population

State and county population estimates are available from the U.S. Census Bureau's 2010 census and can be localized using census block data (U.S. Census Bureau 2010). Population estimates for the South Grand River watershed were derived using geographic information system (GIS) software by overlaying the watershed boundary over a map of census blocks. Wherever the centroid of a census block falls within the watershed boundary, the entire population of the census block is included in the total. If the centroid of the census block is outside the boundary, the population of the entire block is excluded. The municipal population is similarly estimated by selecting census blocks with their centroid in municipal areas. The rural population is calculated as the difference between the municipal population and the total population in the watershed.

Thirty-three municipalities have all or a portion of their area within the South Grand River watershed. As of the 2010 census, eight municipalities and one county are located within U.S. Census Bureau designated urban areas. Urban area designation is one criterion used to determine whether urban stormwater discharges are subject to municipal separate storm sewer system (MS4) permit regulations (see Section 5.1.4). As shown in Table 4, the total population in the South Grand River watershed increased by 41 percent between 1990 and 2010. The population distribution in the watershed is displayed on Figure 4.

Table 4. Population Estimates for the South Grand River Watershed

Municipal			Rural			Total		
1990	**2000**	**2010**	**1990**	**2000**	**2010**	**1990**	**2000**	**2010**
39,593	56,272	76,407	25,574	31,303	33,977	65,167	87,575	110,384

Demographic data from the U.S. Census Bureau is included in EPA's web-based EJSCREEN tool and may be used to identify areas in the watershed with potential environmental justice concerns. The EJSCREEN tool is available at https://www.epa.gov/ejscreen. EPA defines environmental justice as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies (USEPA 2014a). Communities determined to have environmental justice concerns may qualify for financial and strategic assistance for addressing environmental and public health issues. One example of financial assistance the Department offers that may be available to areas having environmental justice concerns is Section 319 grant funding to address nonpoint sources. The Department evaluates 319 grants on a number of criteria, but gives higher priority for selection to proposed projects in disadvantaged communities. Additional grant and financial resource information is available on EPA's environmental justice website at www.epa.gov/environmentaljustice.

The EJSCREEN tool integrates 11 environmental pollution, 6 demographic indicators, and a demographic index based on percent low income and percent minority. EJSCREEN results highlight places that may be candidates for further review, analysis, or outreach to support EPA's environmental justice work. EJSCREEN is currently based on 2010 census data and indicator outputs may change when 2020 census data becomes available. Information on the development, limitations, and intended uses of EJSCREEN, as well as access to the mapping tool can be found at the EJSCREEN website.

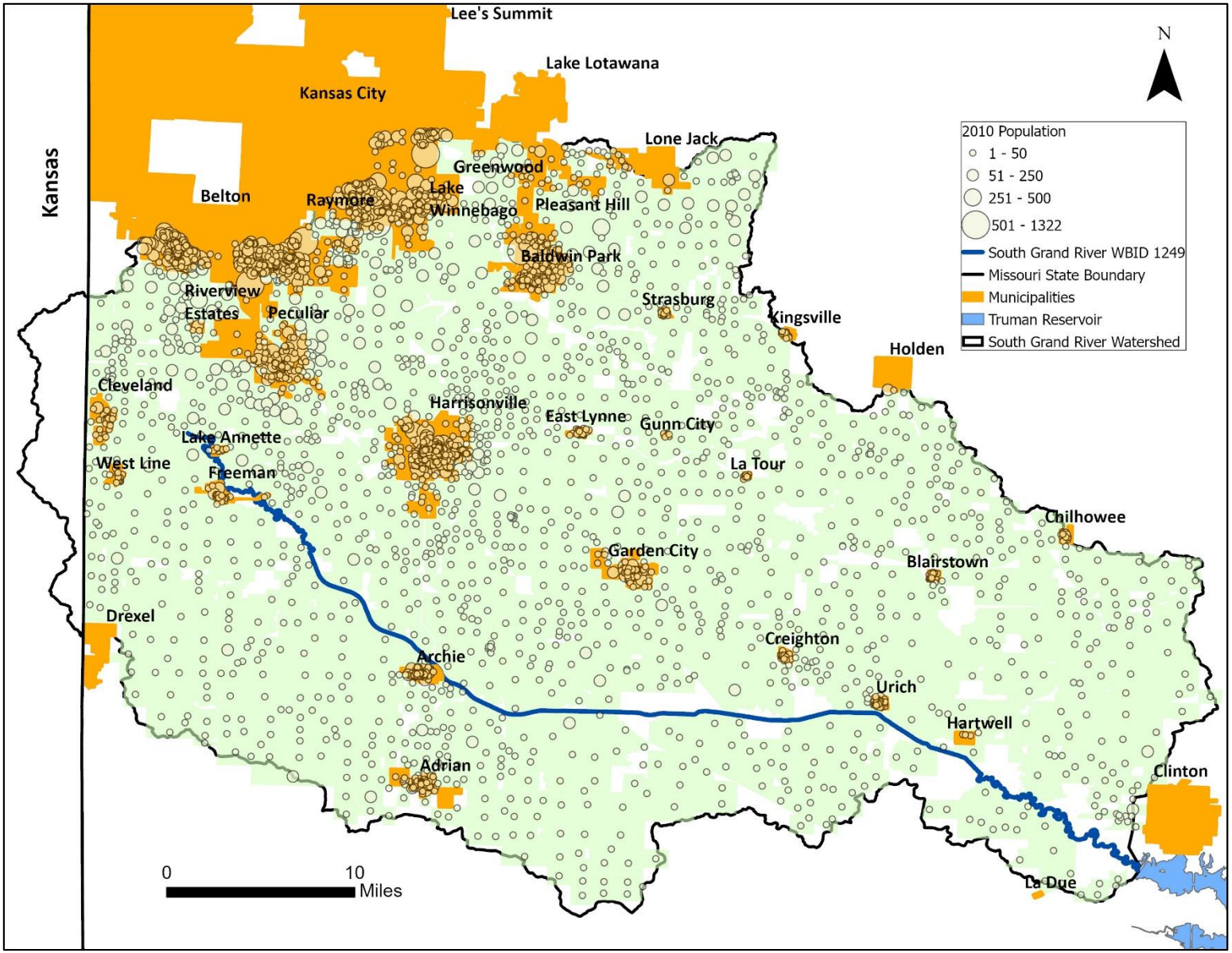

Figure 4. 2010 Population in the South Grand River Watershed

2.4 Land Cover

A land cover analysis was completed using the 2016 National Land Cover Database published by the U.S. Geological Survey (Dewitz 2019). Land cover types present in the South Grand River watershed are summarized in Table 5 and displayed on Figure 5. Seventy-two percent of the watershed is covered by agricultural areas including cultivated cropland and pasture areas potentially used for livestock grazing.

Table 5. Land Cover in the South Grand River Watershed

Land Cover Type	Area Square miles	Percent
Developed, High Intensity	1.7	0.13%
Developed, Medium Intensity	6.5	0.50%
Developed, Low Intensity	34.1	2.59%
Developed, Open Space	54.9	4.17%
Barren Land	2.4	0.18%
Cultivated Crops	334.7	25.43%
Hay and Pasture	614.1	46.66%
Forest	178.1	13.53%
Shrub and Herbaceous	5.4	0.41%
Wetlands	67.7	5.14%
Open Water	16.5	1.25%
Total	1,316	100%

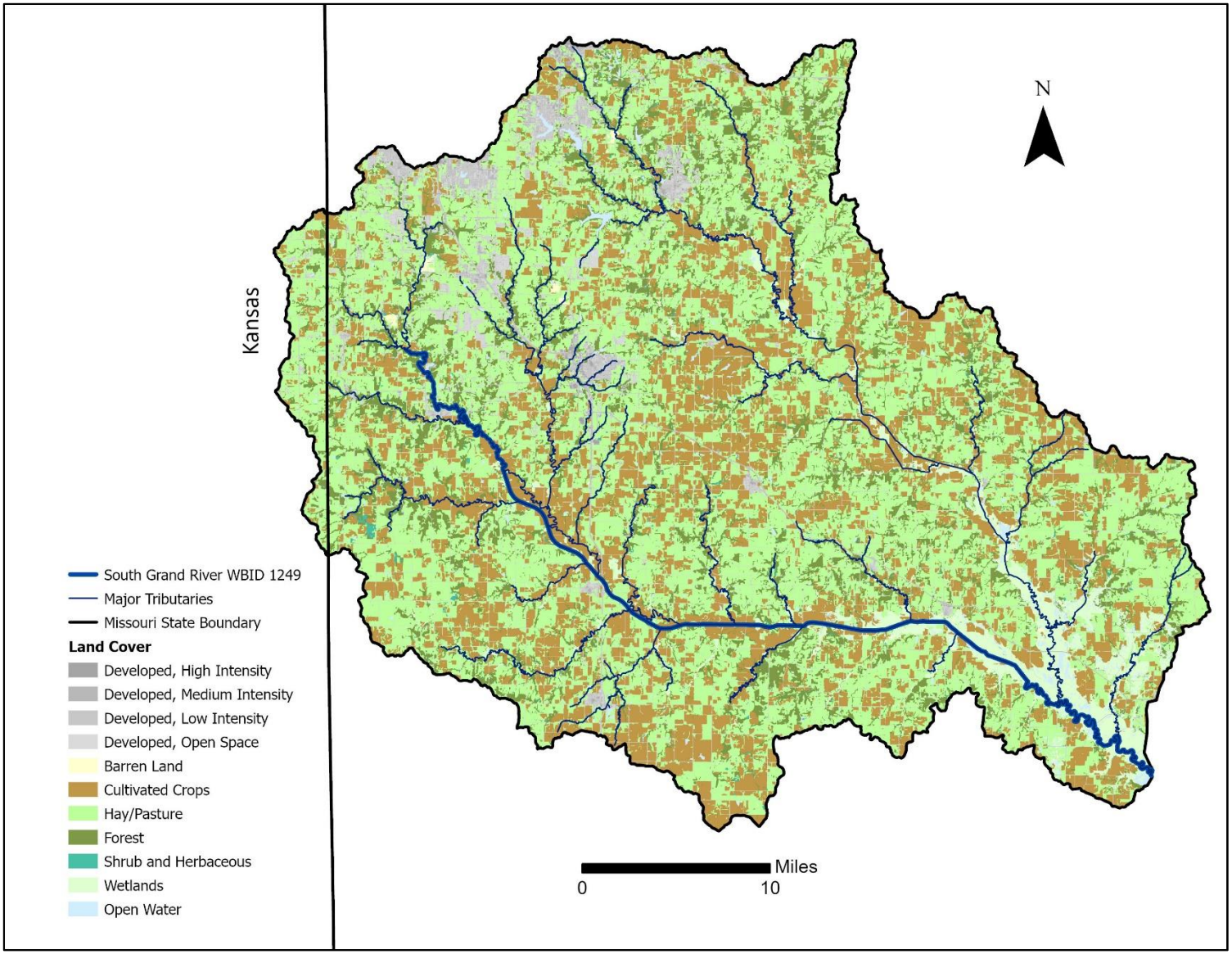

Figure 5. Land Cover in the South Grand River Watershed

3. Applicable Water Quality Standards

TMDLs identify the maximum pollutant load that a water body can assimilate and still attain and maintain water quality standards. Water quality standards are therefore central to the TMDL development process. Under the federal Clean Water Act, every state must adopt water quality standards to protect, maintain, and improve the quality of the nation's surface waters (U.S. Code Title 33, Chapter 26, Subchapter III). Water quality standards consist of three major components: designated uses, water quality criteria, and an antidegradation policy. In accordance with federal regulations at 40 CFR 131.10, Missouri's Water Quality Standards for each individual water body also provide for the attainment and maintenance of water quality in any downstream waters. Revising existing water quality standards is not within the purview of TMDL development. If future water quality monitoring demonstrates that existing water quality standards are not protective of individual water bodies or downstream uses, new water quality standards can be proposed in accordance with the guidance provided in EPA's Water Quality Standards Handbook.[8]

3.1 Designated Uses

Missouri's Water Quality Standards at 10 CSR 20-7.031(1)(C) defines designated uses that are assigned to individual water bodies in accordance with 10 CSR 20-7.031(2) and are listed in 10 CSR 20-7.031, Table G (Lakes) and Table H (Streams). Missouri's Water Quality Standards designate the following uses of South Grand River:

- Irrigation
- Livestock and wildlife protection
- Human health protection
- Warm water habitat (aquatic life)
- Whole body contact recreation category B
- Secondary contact recreation

The whole body contact recreation category B designated use of South Grand River is impaired due to high *E. coli* bacteria concentrations. Whole body contact recreation includes activities that involve direct human contact with waters of the state to the point of complete body submergence (10 CSR 20-7.031(1)(C)2.A.). During whole body contact activities, such as swimming, accidental ingestion of the water may occur and there is direct contact to sensitive body organs, such as the eyes, ears, and nose. Whole body contact category A applies to waters that have been established by the property owner as public swimming areas and waters with documented existing whole body contact recreation uses by the public (10 CSR 20-7.031(1)(C)2.A.(I)). Whole body contact category B applies to waters designated for whole body contact recreation not contained within category A (10 CSR 20-7.031(1)(C)2.A.(II)). Secondary contact recreation, which includes activities such as boating, fishing, and wading, are activities that may result in contact with the water that is either incidental or accidental and the probability of ingesting appreciable quantities of water is minimal (10 CSR 20-7.031(1)(C)2.B.). The secondary contact recreation use is not impaired in South Grand River.

3.2 Water Quality Criteria

Water quality criteria represent a level of water quality that supports and protects particular designated uses. Water quality criteria are expressed as specific numeric criteria and as general narrative statements. Missouri's Water Quality Standards (10 CSR 20-7.031(4) and (5)) establish

[8] https://www.epa.gov/wqs-tech/water-quality-standards-handbook

general criteria applicable to all waters of the state at all times and specific criteria applicable to waters contained in 10 CSR 20-7.031, Tables G and H. Specific numeric *E. coli* bacteria criteria are given in Missouri's Water Quality Standards at 10 CSR 20-7.031(5)(C) and Table A1. For whole body contact recreation category B waters, *E. coli* concentrations during the recreational season (April through October) shall not exceed the geometric mean of 206 colony forming units (cfu) per 100 milliliters (mL) of water. This criterion is also protective of secondary contact recreational uses.

3.3 Antidegradation Policy

Missouri's Water Quality Standards include the EPA "three-tiered" approach to antidegradation and may be found at 10 CSR 20-7.031(3).

Tier 1 – Protects public health, existing instream water uses, and a level of water quality necessary to maintain and protect existing uses. Tier 1 provides the absolute floor of water quality for all waters of the United States. Existing instream water uses are those uses that were attained on or after November 28, 1975, the date of EPA's first Water Quality Standards Regulation.

Tier 2 – Protects and maintains the existing level of water quality where it is better than applicable water quality criteria. Before water quality in Tier 2 waters can be lowered, there must be an antidegradation review consisting of: (1) a finding that it is necessary to accommodate important economic and social development in the area where the waters are located; (2) full satisfaction of all intergovernmental coordination and public participation provisions; and (3) assurance that the highest statutory and regulatory requirements for point sources and best management practices for nonpoint sources are achieved. Furthermore, water quality may not be lowered to less than the level necessary to fully protect the "fishable/swimmable" uses and other existing uses.

Tier 3 – Protects the quality of outstanding national and state resource waters, such as waters of national and state parks, wildlife refuges, and waters of exceptional recreational or ecological significance. There may be no new or increased discharges to these waters and no new or increased discharges to tributaries of these waters that would result in lower water quality.

Waters in which a pollutant is at, near, or exceeds the water quality criteria are considered in Tier 1 status for that pollutant. Therefore, the antidegradation goals for South Grand River are to restore water quality to levels that meet water quality standards.

4. Defining the Problem

E. coli are bacteria found in the intestines of humans and warm-blooded animals and are used as indicators of potential fecal contamination and risk of pathogen-induced illness to humans. In accordance with Missouri's 2020 Listing Methodology Document, the whole body contact recreation category B designated use for South Grand River is impaired because the geometric means of *E. coli* samples collected during the recreational season were greater than 206 cfu/100 mL in the most recent three years having available data with five or more samples.[9] Sufficient data consistent with the assessment methodology are available to support these listings and are summarized in Table 6. As

[9] Listing Methodology documents are available online at dnr.mo.gov/water/what-were-doing/water-planning/quality-standards-impaired-waters-total-maximum-daily-loads/impaired-waters

shown, *E. coli* concentrations exceeded the geometric mean of 206 cfu/100 mL during the recreational season in 1999, 2001, 2007, and 2019 when at least five samples were collected. *E. coli* data are available for each year between 2008 and 2018; however, fewer than five samples were collected in those years. Individual *E. coli* sample concentrations ranged from 7 cfu/100mL to 8,200 cfu/100 mL.

Individual *E. coli* measurements are provided in Appendix B to illustrate the nature of the impairment but were not used in the calculation of TMDL loading capacities or allocations. Individual measurements may be used to estimate pollutant reduction targets, to target implementation activities, and to select appropriate best management practices (BMPs). Reduction targets for South Grand River are presented in a supplemental TMDL implementation strategies document available online at dnr.mo.gov/water/what-were-doing/water-planning/quality-standards-impaired-waters-total-maximum-daily-loads/tmdls.

Table 6. Summary of Recreational Season *E. coli* Data for South Grand River (WBID 1249)[10]

Recreational Season	Number of Samples	Minimum (cfu/100 mL)	Maximum (cfu/100 mL)	Geometric Mean (cfu/100 mL)
1999	6	46	5,500	207.12
2001	7	1	29,000	223.88
2007	5	43	15,000	307.03
2019	5	96	9,100	362.35

5. Source Inventory and Assessment

Point (typically regulated) and nonpoint (typically unregulated) sources may contribute to the elevated *E. coli* concentrations in the impaired water bodies. The following source inventory and assessment identifies and characterizes known, suspected, and potential sources of bacteria loading to South Grand River. Sources of bacteria loading are identified and quantified to the extent that information is available.

5.1 Point Sources

Point sources are defined by Section 644.016(16) of the Missouri Clean Water Law and are regulated pursuant to the National Pollutant Discharge Elimination System through the Missouri State Operating Permit program.[11,12] A point source is defined as "any discernible, confined, and

[10] *E. coli* data may be reported in units of most probable number (MPN) or colony forming units (cfu) depending upon the analysis method used. Data reported as cfu is an actual count of bacteria colonies, whereas MPN is a statistical approximation. Although differences may exist, they are often used interchangeably. For purposes of this TMDL, all *E. coli* data are presented in units of cfu regardless of the methodology used for simplicity and in order to maintain consistency with Missouri Water Quality Standards.

[11] The Missouri State Operating Permit program is Missouri's program for administering the federal National Pollutant Discharge Elimination System (NPDES). Generally, the Clean Water Act requires all point sources that discharge pollutants to waters of the United States to obtain an NPDES permit. Issued and proposed operating permits are available online at dnr.mo.gov/water/business-industry-other-entities/permits-certification-engineering-fees/wastewater.

[12] Point sources in Kansas are regulated by the Kansas Department of Health and Environment. Missouri cannot impose TMDL wasteload allocations onto another state, therefore, wasteload allocations in this TMDL are calculated only for Missouri permitted facilities. In order to achieve water quality standards through the loading targets established by this TMDL, it must be assumed that any point source pollutant contributions from Kansas will be limited to ensure Missouri's water quality standards are met at the state line. For this TMDL, the load allocation accounts for any potential point source and nonpoint source pollutant contributions originating from Kansas.

discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. Point source does not include agricultural storm water discharges and return flows from irrigated agriculture." Based on this definition, point sources include domestic wastewater treatment facilities, industrial and commercial facilities, concentrated animal feeding operations (CAFOs), MS4s, and stormwater discharges from industrial areas and construction sites. Illicit straight pipe discharges are also point sources but are illegal and therefore unpermitted. Pollutant loading from point sources is typically most evident during low-flow conditions when stormwater influences are lower or nonexistent.

5.1.1 Domestic Wastewater Treatment Facilities

Domestic wastewater is primarily household waste, including graywater and sewage. Domestic wastewater treatment facilities include both publicly owned (municipal and sewer districts) and privately owned facilities. Untreated or inadequately treated domestic wastewater discharges can be significant sources of bacteria to receiving waters (USEPA 1986). Facilities equipped with disinfection technologies discharge *E. coli* at very low concentrations and should not cause or contribute to bacteria impairments. Facilities that use effluent for irrigation (land application) or otherwise do not directly discharge to streams during the recreational season also should not cause or contribute to *E. coli* impairments.

10 CSR 20-7.015 requires recreational season *E. coli* permit limits for all domestic wastewater treatment facilities within two miles upstream of waters with whole body contact designated uses. All domestic wastewater treatment facilities in the South Grand River watershed have current or future *E. coli* limits in their operating permits. Currently, five publicly owned and four privately owned domestic wastewater treatment facilities disinfect wastewater prior to discharge. Ten publicly owned and eight privately owned domestic wastewater treatment facilities do not currently disinfect wastewater nor implement other appropriate measures to eliminate *E. coli* from effluent during the recreational season. Without disinfection treatment or other appropriate measures, those 18 facilities have the potential to cause or contribute to the *E. coli* impairment in the South Grand River. Six facilities operate under permits that do not allow direct discharge to surface waters and are not expected to cause or contribute to the *E. coli* impairment in the South Grand River when all permit conditions are met. The locations of domestic wastewater treatment facilities are displayed on Figure 6.

The cities of Belton and Harrisonville and the Little Blue Valley Sewer District (LBVSD) operate major municipal domestic wastewater treatment facilities with design flows greater than 1 million gallons per day (MGD). Fourteen other municipalities and Jackson County Department of Public Works operate minor domestic wastewater treatment facilities with design flows ranging from 21,000 to 750,000 gallons per day (GPD). Publicly owned domestic wastewater treatment facilities are presented in Table 7.

Thirteen privately owned facilities discharge within the South Grand River watershed. Four additional facilities in the South Grand River watershed are no discharge facilities that land apply wastewater through irrigation systems. Two of those operate under Missouri General Permit 823 (MOG823) for Land Application of Domestic Wastewater. The Department is transferring many site-specific domestic wastewater operating permits to a general permit for facilities that discharge less than 50,000 GPD (MOGD). Lagoon systems are not eligible for the general permit. The MOGD permit allows discharge, and facilities that operate under the general permit that do not

disinfect effluent or otherwise control *E. coli* concentrations during the recreational season may contribute to *E. coli* impairments in downstream water bodies. Privately owned domestic wastewater treatment facilities are presented in Table 8. Issuance of a MOGD permit results in termination of the prior site-specific permit. Where MOGD permits have recently been issued, the previous site-specific permit number is shown in parenthesis for reference.

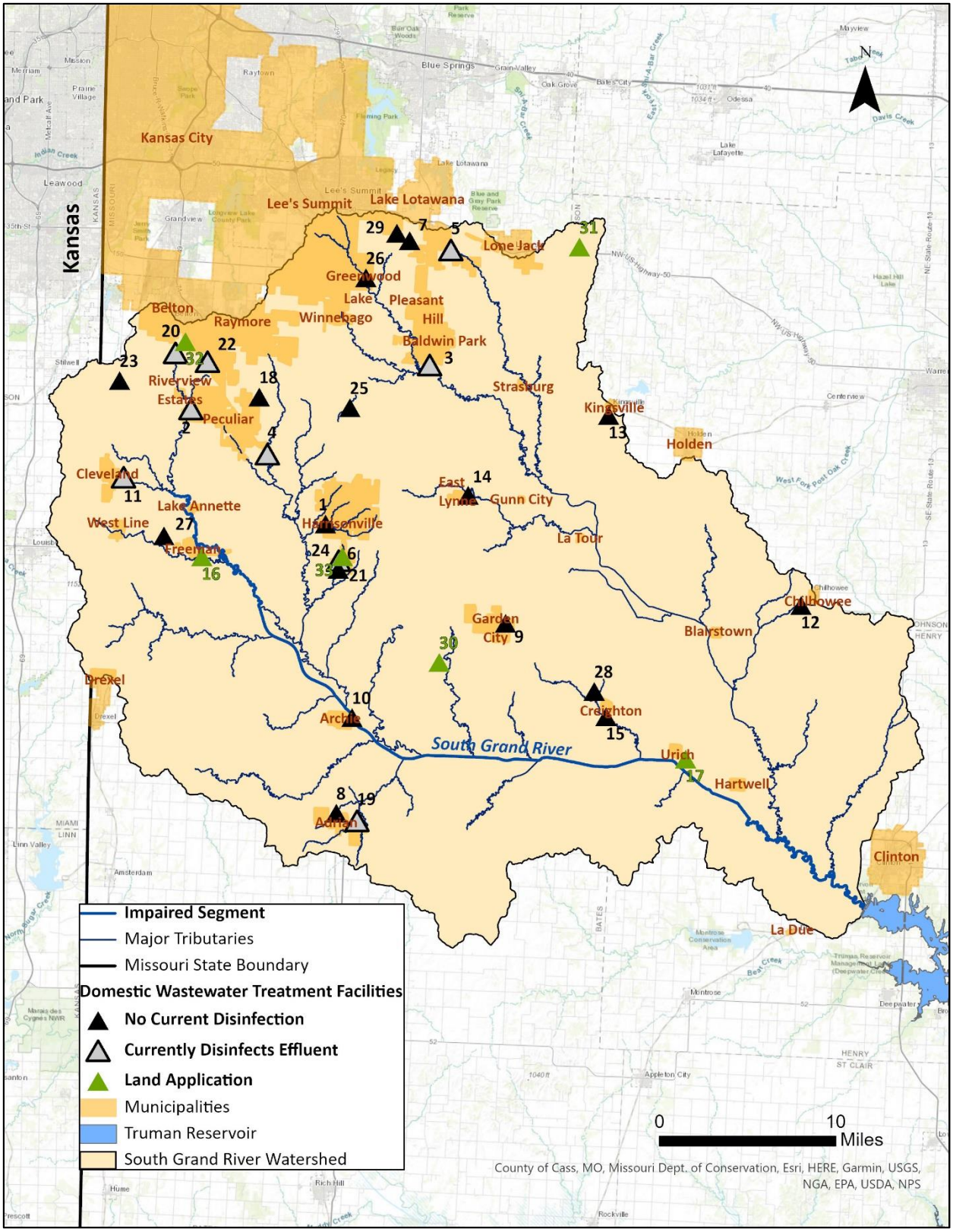

Figure 6. Domestic Wastewater Treatment Facilities in the South Grand River Watershed

Table 7. Publicly Owned Domestic Wastewater Treatment Facilities

Map ID Figure 6	Permit ID	Name	Design Flow	Actual Flow	Discharge During Recreational Season?	Currently Disinfect Effluent?	Active *E. coli* Limits in Permit?	Future *E. coli* Limits in Permit?	Permit Expiration[13]
Major Municipal and Other Public Mechanical Treatment									
1	MO0028070	Harrisonville WWTF	2.40 MGD	1.40 MGD	Yes	No	No	12/1/2021	3/31/2021
2	MO0117412	Belton WWTP	2.26 MGD	1.50 MGD	Yes	Yes	Yes	Yes	12/31/2025
3	MO0058629	LBVSD Middle Big Creek WWTP	2.25 MGD	1.22 MGD	Yes	Yes	Yes	Yes	3/31/2026
Minor Municipal and Other Public Mechanical Treatment (Design Flow in GPD)									
4	MO0089443	Peculiar WWTP	750,000	600,000	Yes	Yes	Yes	Yes	12/31/2025
5	MO0131962	Lake Lotawana CID WWTP No. 2	300,000	91,000	Yes	Yes	Yes	Yes	12/31/2020
6	MO0126179	Harrisonville South WWTP	22,500	9,000	Yes	No	No	12/1/2021	3/31/2021
7	MO0107476	Sanitary Sewer District 103 WWTF	21,000	18,000	Yes	No	No	5/1/2021	9/30/2025
Minor Municipal Lagoon Treatment (Design Flow in GPD)									
8	MO0112623	Adrian Wastewater Lagoon	270,000	214,474	Yes	No	No	7/1/2024	3/31/2021
9	MO0046647	Garden City WWTF	144,000	121,469	Yes	No	No	8/1/2021	9/30/2025
10	MO0048208	Archie WWTF	130,000	16,000	Yes	No	Yes	Yes	6/30/2026
11	MO0111287	Cleveland WWTF	100,000	12,000	Yes	Yes	Yes	Yes	3/31/2026
12	MO0096091	Chilhowee WWTF	60,000	26,000	Yes	No	No	11/1/2025	12/31/2025
13	MO0025844	Kingsville WWTF	51,000	48,300	Yes	No	No	6/1/2022	6/30/2021
14	MO0099961	East Lynne WWTF	38,500	15,500	Yes	No	Yes	Yes	6/30/2026
15	MO0100102	Creighton WWTF	36,000	41,600	Yes	No	No	5/1/2021	12/31/2020
Minor Municipal Effluent is Land Applied (No Direct Discharge)									
16	MO0104248	Freeman WWTF	85,500	NA	NA	NA	NA	NA	6/30/2021
17	MO0039764	Urich WWTF	60,000	NA	NA	NA	NA	NA	6/30/2026

[13] When an NPDES permit expires, the permittee remains bound by the conditions of that expired permit until either the permit is terminated or a new permit is issued.

Table 8. Privately Owned Domestic Wastewater Treatment Facilities

Map ID Figure 6	Permit ID	Name	Design Flow GPD	Actual Flow GPD	Discharge During Recreational Season?	Currently Disinfect Effluent?	Active *E. coli* Limits in Permit?	Future *E. coli* Limits in Permit?	Permit Expiration
Mechanical Treatment									
18	MOGD00525 (MO0107484)	MBCH-Byrne Campus	2,500	1,000	Yes	No	Yes	Yes	6/30/2024
19	MO0125733	Deer Creek Lake, LLC (Home Owners Association)	9,999	1,500	Yes	Yes	Fecal Coliform	Yes	1/31/2026
20	MOGD00544 (MO0101796)	Oasis Mobile Home Park	20,000	19,700	Yes	Yes	Yes	Yes	6/30/2024
21	MO0138215	Sapp Brothers Travel Center	20,000	0	Yes	Yes	Yes	Yes	3/31/2026
22	MOGD00532 (MO0102300)	Pickering Place Inc	30,000	11,600	Yes	Yes	Yes	Yes	6/30/2024
Lagoon Treatment									
23	MO0124150	RK Collision Repair Center	1,200	0	No	No	No	1/1/2022	3/31/2026
24	MO0107301	Slumber Inn Motel	4,999	3,000	Yes	No	Yes	Yes	3/31/2023
25	MO0112461	Country Creek Estates	13,750	13,750	Yes	No	Yes	Yes	9/30/2025
26	MO0089931	Butterbaugh Mobile Home Park	24,000	3,200	Yes	No	Yes	Yes	9/30/2024
27	MO0109282	Cass County Midway R-1 Schools Lagoon	24,900	5,000	Yes	No	Yes	Yes	6/30/2026
28	MO0090697	Sherwood Cass R-VIII School	12,000	1,000	Yes	No	No	2/1/2022	12/31/2020
Other Treatment									
29	MO0125351	Woodland Elementary School (Sand/Rock Filter)	9,000	3,000	Yes	No	No	12/1/2022	9/30/2020
Effluent is Land Applied (No Direct Discharge)									
30	MO0139181	Kornukopia Farms LLC	0	0	NA	NA	NA	NA	6/30/2021
31	MO0139009	Republic Foods Facility	0	0	NA	NA	NA	NA	3/31/2021
32	MOG823037	Crown Trailer Sales Inc.	0	0	NA	NA	NA	NA	8/24/2022
33	MOG823169	Grab and Go	0	0	NA	NA	NA	NA	8/24/2022

Potential bacteria loading from domestic wastewater treatment facilities may also occur from sanitary sewer overflows. Sanitary sewer systems convey residential wastewater, and in some cases commercial and industrial wastewater, to the domestic wastewater treatment facility. Sanitary sewer systems can handle limited amounts of inflow from stormwater and infiltration from groundwater but are typically not designed to collect large amounts of runoff from precipitation events. Overflows from sanitary sewer systems may result in elevated bacteria counts in nearby surface waters (USEPA 1996). Sanitary sewer overflows can be caused by high volume precipitation events and can also occur during dry weather due to blockages, line breaks, sewer defects, power failures, and vandalism. Sanitary sewer overflows can occur at any point in the collection system but are typically evident by overflowing manholes and backups into private residences. Such overflows may discharge directly to nearby waterways or may be restricted to terrestrial locations. These discharges are not authorized by the federal Clean Water Act or the Missouri Clean Water Law.

Table 9 summarizes reported sanitary sewer overflows that occurred during the recreational season between 2016 and 2020. Sanitary sewer overflows are typically not significant contributors of *E. coli* to the impaired water bodies because unintentional discharge of untreated domestic wastewater is rare and temporary in nature. The Belton Wastewater Treatment Facility reported that 22 of its 29 sanitary sewer overflow events entered a waterway. Although various reasons were cited for these overflow events, the majority resulted during rain events. For this reason, sanitary sewer overflows from the Belton sewer system may be a potential contributor of *E. coli* during some wet weather flow conditions. NPDES permits and 40 CFR Part 122.41(e) require permittees to properly operate and maintain the facility's collection system. This is implemented through a special permit condition or schedule of compliance.

Table 9. Reported Sanitary Sewer Overflows 2016-2020

Permit ID	Name	Number of SSO Events
MO0028070	Harrisonville WWTF	1
MO0117412	Belton WWTP	29
MO0058629	LBVSD Middle Big Creek WWTP	4
MO0089443	Peculiar WWTP	2
MO0112623	Adrian Wastewater Lagoon	1
MO0111287	Cleveland WWTF	2
MO0096091	Chilhowee WWTF	1
MO0100102	Creighton WWTF	1
MO0104248	Freeman WWTF	1

5.1.2 Industrial and Commercial Facilities

Industrial and commercial facilities discharge process water used or generated during mining, manufacturing, electricity generation, or food processing activities, and may also include landfills. Mining and manufacturing facilities are not expected to cause or contribute to bacteria impairments. Food processing wastewater may contain bacteria. Discharge from industrial and commercial facilities may include both process water and stormwater runoff. The locations of industrial and commercial facilities are displayed in Figure 7. Specific facility information is listed in Table 10. Discharges from the facilities in Table 10 are not expected to contain *E. coli* in amounts that cause or contribute to downstream impairments. Three of the site-specific industrial permits do not allow discharge to surface waters.

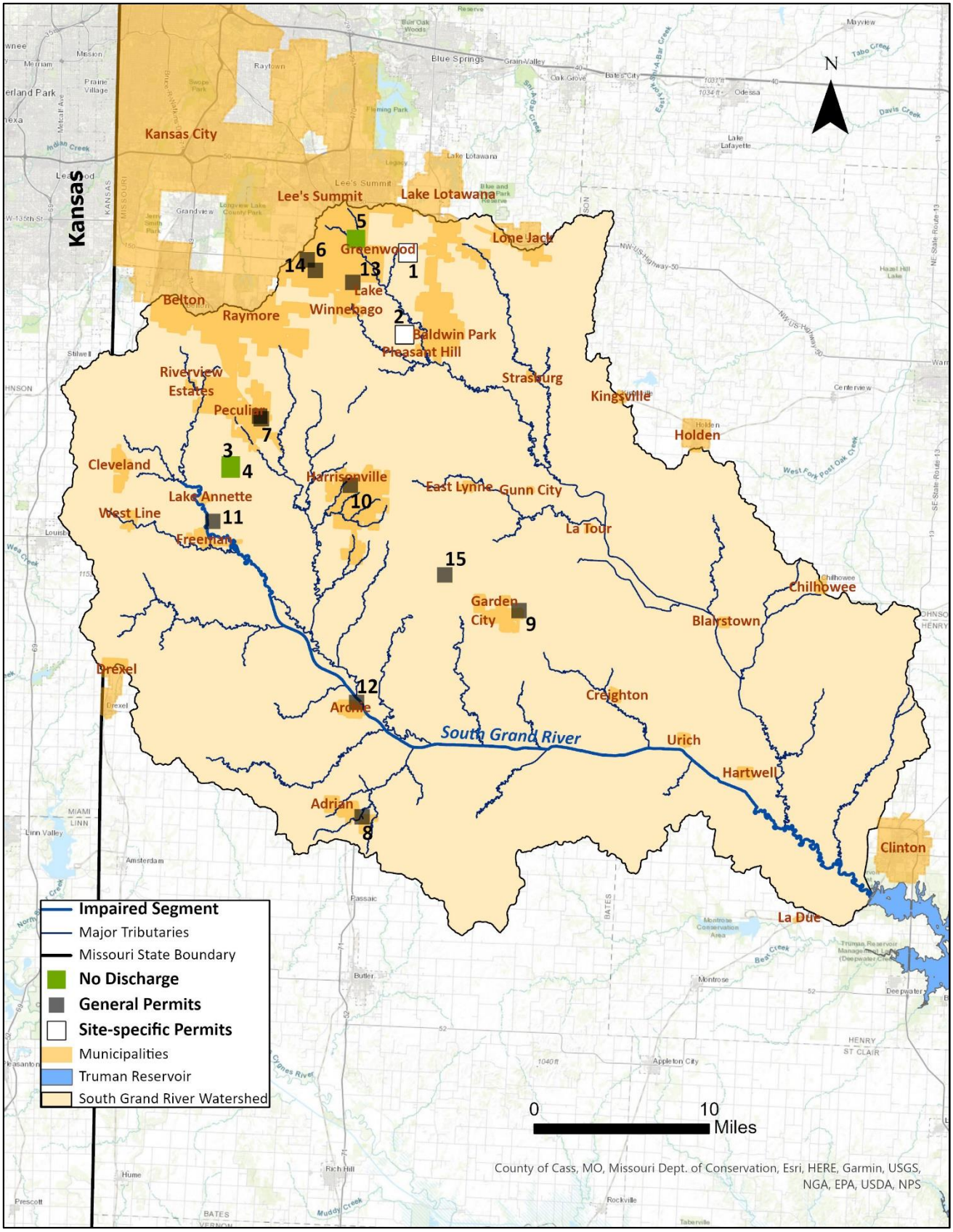

Figure 7. Industrial and Commercial Facilities in the South Grand River Watershed

Table 10. Industrial and Commercial Facilities

Map ID Figure 7	Permit ID	Facility	Effluent Type	Expiration
Site-Specific Discharge Permits				
1	MO0133141	Greenwood Generating Station	Cooling water and Stormwater	3/31/2024
2	MO0124940	Dogwood Energy Facility	Cooling water and Stormwater	9/30/2025
Site-Specific No Discharge Permits				
3	MO0131857	South Harper Generating Station	Cooling water and Domestic Wastewater	9/30/2020
4	MO0128988	Southern Star Central Gas Pipeline-Pecular Compressor Station	Groundwater Seepage and Stormwater	9/30/2025
5	MO0110876	Lee's Summit Resource Recovery Park	Leachate Stormwater	9/30/2025
General Permits				
6	MOG140063	Meiners Market	Pavement Wash Treatment	6/30/2024
7	MOG140077	Flying J No. 672	Pavement Wash Treatment	6/30/2024
7	MOG940237	Pilot Travel Centers #672	Fuel Spill Wash	1/31/2022
8	MOG640061	Adrain Water Treatment Facility	Water Treatment Backwash	2/24/2024
9	MOG640086	Garden City WTP	Water Treatment Backwash	2/24/2024
10	MOG640094	Harrisonville Water Treatment Plant	Water Treatment Backwash	2/24/2024
11	MOG640108	Cass County PWSD #7	Water Treatment Backwash	2/24/2024
12	MOG640207	Archie WTP	Water Treatment Backwash	2/24/2024
13	MOG690050	Lake Winnebago Decant Pond	Dredge Water	7/31/2024
14	MOG760038	Raintree Lake Property Owners Association	Swimming Pool Discharge	7/31/2024
15	MOG822248	Kurzweil's Country Meats	No Discharge	5/22/2022

5.1.3 Concentrated Animal Feeding Operations

Animal wastes generated from CAFOs can be a source of bacteria to water bodies (Rogers and Haines 2005). Pursuant to 10 CSR 20-6.300, permits are required for CAFOs that confine and feed or maintain more than 1,000 animal units for 45 days or more during any 12-month period.[14] Permits may be required for facilities with fewer animal units if pollutants are discharged directly into waters of the state or other water quality issues are discovered. In Missouri, CAFOs are subject to the requirements of site-specific permits or one of two general permits (MO-G01 or MO-GS1).[15]

Five CAFO facilities are located in the South Grand River watershed (Table 11). Permits issued to Prairie View Pork, LLC and J.D. Animal waste applied on areas under the control of a CAFO are subject to conditions found in the permit, which include a requirement for the CAFO to develop a nutrient management plan. Section 640.760 RSMo establishes setback distances for surface application of liquefied manure from a CAFO by a third party.[16] Although potential sources of *E. coli*, permits prohibit direct discharges or runoff from land applications into water bodies. Therefore when all permit requirements are met, CAFOs should not be significant contributors of *E. coli* to the South Grand River. The locations of CAFOs are displayed in Figure 8.

Table 11. CAFOs in the South Grand River Watershed

Map ID	Permit No.	Facility Name	Class Size[17]	Animal Type
1	MOGS10068	Prairie View Pork, LLC	IB	Hogs
2	MOGS10105	J.D. Howerton and Sons	IC	Hogs
3	MOGS10534	Lone Tree Farms, Inc.	IC	Hogs
4	MOGS10511	Reliance Pork	IC	Hogs
5	MOG010367	Kurzweil Livestock LLC	IC	Hogs

[14] As defined by 10 CSR 20-6.300(1)(B)2, An animal unit is a unit of measurement to compare various animal types at an animal feeding operation. One (1) animal unit equals the following: 1.0 beef cow or feeder, cow/calf pair, veal calf, or dairy heifer; 0.5 horse; 0.7 mature dairy cow; 2.5 swine weighing over 55 pounds; 10 swine weighing less than 55 pounds; 10 sheep, lamb, or meat and dairy goats; 30 chicken laying hens or broilers with a wet handling system; 82 chicken laying hens without a wet handling system; 55 turkeys in grow-out phase; 125 chicken broilers, chicken pullets, or turkey poults in brood phase without a wet handling system.

[15] MO-GS1 does not authorize any direct discharges. The MO-G01 allows discharge only in the event of weather that exceeds the criteria of a catastrophic storm, and only authorizes discharge of the portion of stormwater flow that exceeds the design storm event, which includes the direct precipitation and runoff from the 25-year, 24-hour storm event.

[16] Section 640.760 RSMo requires all third party applicators of liquefied manure from CAFOs to maintain the following minimum setback distances: 50 feet from a property boundary, 300 feet from any public drinking water lake, 300 feet from any public drinking water well or intake structure, 100 feet from any perennial and intermittent streams without vegetation abutting such streams, and 35 feet from any perennial and intermittent streams with vegetation abutting such streams.

[17] An operation's "class size" is a category that is based upon the total number of animal units confined at an operation. The Class IC, IB, and IA are categories that start at 1,000, 3,000, and 7,000 animal units respectively, all of which are required by state regulation to obtain a permit. (1,000 animal units is equal to 2,500 swine; 100,000 broilers; 700 dairy cows; or 1,000 beef steers).

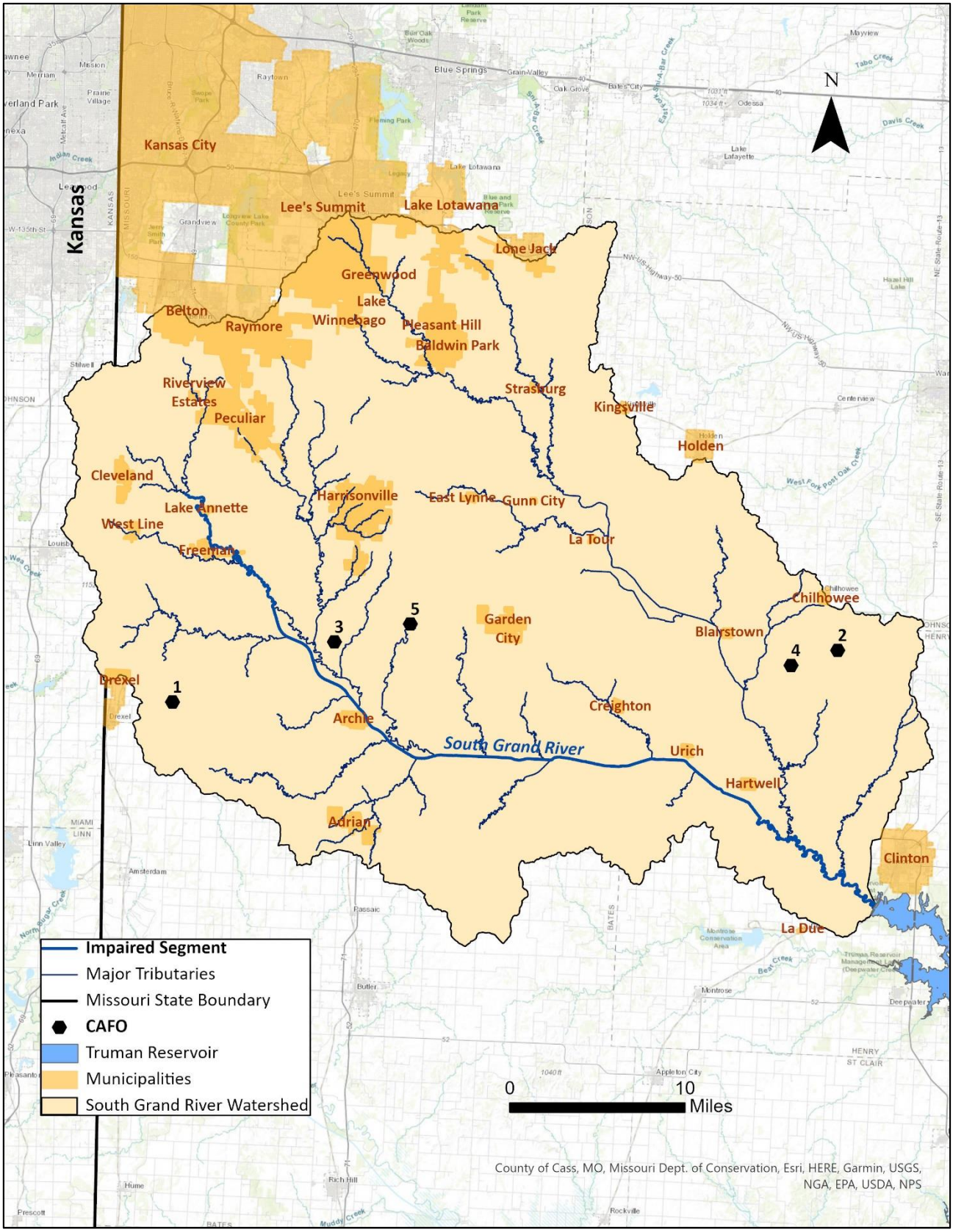

Figure 8. CAFOs in the South Grand River Watershed

5.1.4 Municipal Separate Storm Sewer Systems

Municipal separate storm sewer systems (MS4s) are stormwater conveyance systems owned by a public entity that are not part of a sanitary sewer system, a combined sewer system, or part of a domestic wastewater treatment facility. Federal regulations issued in 1990 require that discharges from MS4s be regulated by permits if the population of a municipality, or in some cases a county, is 100,000 or more (Phase I). As of 1999, federal regulations require permits for discharges from small MS4s that are located within a U.S. Census Bureau defined urban area or are required to hold a MS4 permit based on other criteria by the permitting authority (Phase II). As discussed in Section 2.3, at the time of the 2010 census, eight municipalities in the South Grand River watershed and one county are located within portions of U.S. Census Bureau designated urban areas. Table 12 lists the regulated MS4s within these urban areas. The Missouri Department of Transportation (MoDOT) also holds a transportation separate storm sewer system (TS4) permit (MO0137910) that applies to roadways within the urban areas.

Table 12. Regulated MS4s in South Grand River Watershed

Permit ID	Municipality	Area in Watershed (square miles)	Percent of Watershed
MOR040018	Belton	5.40	0.41%
MOR040068	Greenwood	3.97	0.30%
MOR040116	Harrisonville	10.02	0.76%
MO0130516	Kansas City	0.09	0.01%
MOR040084	Lake Lotawana	3.49	0.27%
MOR040117	Lake Winnebago	2.73	0.21%
MOR040016 MOR040026	Lee's Summit and Cass County	15.78	1.20%
MOR040118	Peculiar	8.45	0.64%
MOR040029	Raymore	13.10	1.00%
	Total MS4 Area	**63.03**	**4.8%**

MS4 permits authorize the discharge of urban stormwater runoff. In general, urban runoff contains high levels of bacteria and may contribute to exceedances of *E. coli* criteria during and immediately after storm events in most streams throughout the country (EPA 1983). Runoff contaminated with *E. coli* flows from open areas where soil erosion is common and from heavily paved areas (EPA and Pitt 2002). For these reasons, urban runoff is a potential contributor to high *E. coli* concentrations in South Grand River.

Urban sourced bacterial loading to streams can be from sanitary sewer overflows, as discussed in Section 5.1.1 of this document, and from residential and green space runoff carrying domestic and wild animal waste. Birds, dogs, cats, and rodents are documented as common sources of *E. coli* in urban stormwater (Burton and Pitt 2002). Irrigation runoff from residential lawns where pet wastes are present may also contribute *E. coli* loads to surface waters. Another source of urban stormwater is runoff originating from highway corridors. The Federal Highway Administration published research identifying bird droppings, soil, and vehicles carrying livestock and stockyard wastes as sources that may periodically "seed" highway corridors with *E. coli* and other pathogens. The study further notes that the magnitude of contaminated runoff from highway systems are site-specific and can be affected by numerous factors, such as traffic, design, maintenance, land use, climate, and accidental spills (FHWA 1984).

For these reasons, the significance of any highway contributions of bacteria in the South Grand River watershed cannot be quantified in this TMDL report. Due to the intermittent and potentially sporadic nature of highway bacterial contributions described in the federal study, the MoDOT TS4 is not expected to be a significant contributor to the bacteria impairment in South Grand River.

Although stormwater discharges are often untreated, MS4 permit holders must develop, implement, and enforce stormwater management plans to reduce the contamination of stormwater runoff and prohibit illicit discharges. Stormwater management plans must include measurable goals, annual reports, and six minimum control measures. These control measures include public education and outreach, public participation and involvement, illicit discharge detection and elimination, construction site runoff control, post-construction runoff control, and pollution prevention. MS4 permits may also require the development of supplemental TMDL Assumptions and Requirement Attainment Plans (ARAPs) where applicable. Missouri's list of Regulated MS4s and associated stormwater management plans can be accessed at dnr.mo.gov/water/business-industry-other-entities/permits-certification-engineering-fees/stormwater/municipal-separate-storm-sewer-systems-ms4.

5.1.5 Other General Permitted Wastewater and Stormwater Discharges

General permits are issued for certain wastewater (MO-G) and stormwater (MO-R) discharges based on the type of activity and are intended to be flexible enough to allow for ease and speed of issuance, but must also protect water quality. General wastewater and stormwater permits are issued for activities similar enough to be covered by a single set of requirements. Existing and future activities for which general wastewater or stormwater permits are issued are expected to be conducted in compliance with all permit conditions including monitoring requirements and discharge limitations. Permit conditions are intended to protect the designated uses of all water bodies within the watershed. Activities conducted in accordance with these general and stormwater permit requirements are not expected to contribute *E. coli* loads in amounts substantial enough to cause or contribute to surface water impairments. Per 10 CSR 20-6.010(13)(C), if at any time the Department determines that a general stormwater permit is not providing adequate water quality protection, the Department may require the owner or operator of a permitted site or activity to obtain a site-specific operating permit. Other general permitted wastewater and stormwater discharges not already discussed in previous sections are displayed on Figure 9 and listed in Table 13.

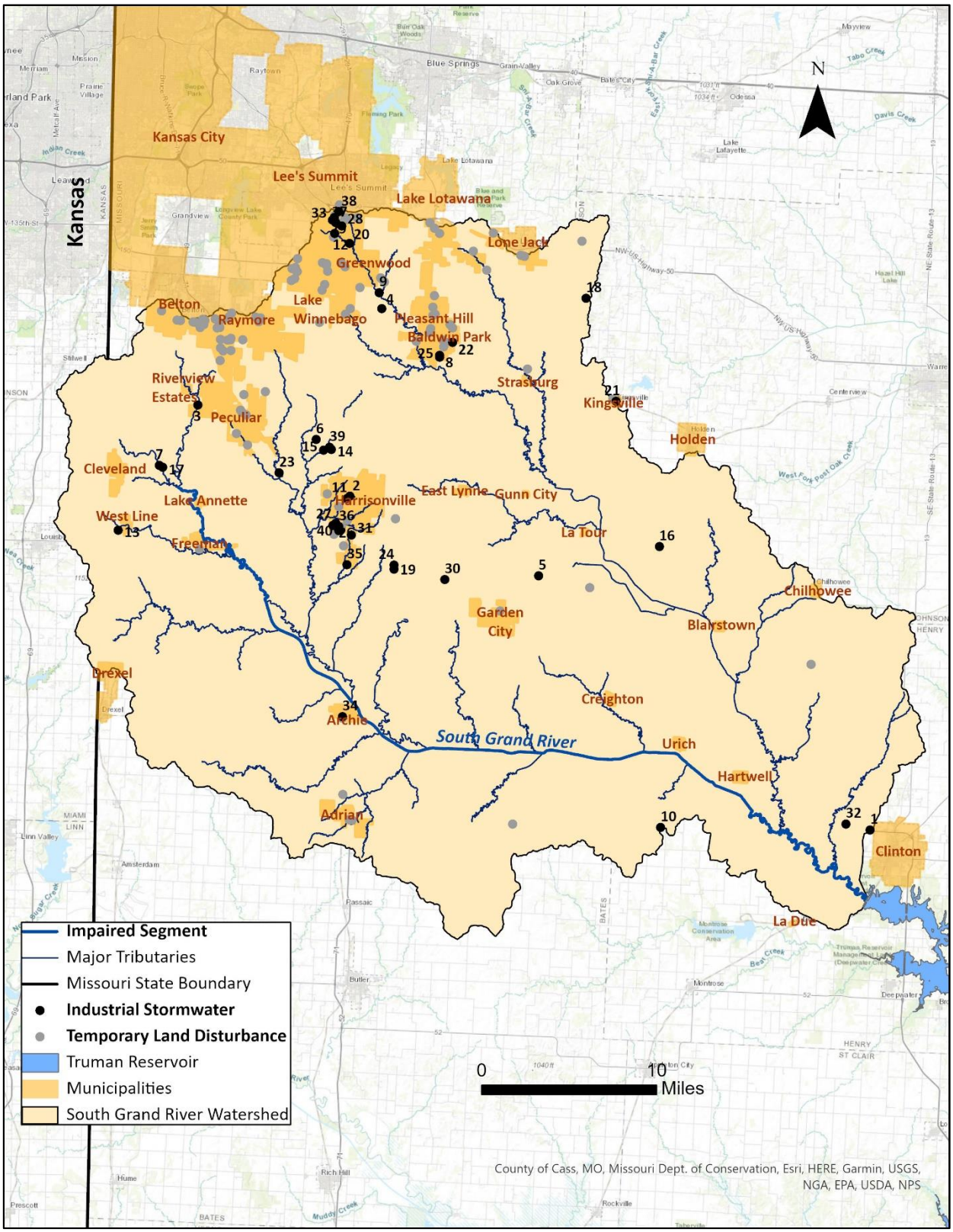

Figure 9. General Permitted Wastewater and Stormwater Discharges in the South Grand River Watershed

Table 13. Industrial Site General Stormwater Permits

Map ID Figure 9	Permit No.	Facility	Expires
MOG35 – Petroleum Storage <250,000			
1	MOG350054	MFA Oil Bulk Plant - Clinton	9/17/2022
2	MOG350103	MFA Oil Bulk Plant - Harrisonville	9/17/2022
MOG49 – Limestone Quarries			
3	MOG490057	Martin M. Materials - Peculiar Quarry	4/30/2022
4	MOG490060	Martin Marietta Materials-Greenwood Quarry	4/30/2022
5	MOG490095	APAC - Garden City Quarry	4/30/2022
6	MOG490101	Harrisonville Quarry	4/30/2022
7	MOG490172	Beyer Crushed Rock Company	4/30/2022
8	MOG490283	Whistle Redi-Mix, Inc - Pleasant Hill Pl	4/30/2022
9	MOG490315	MLC Ready Mix	4/30/2022
10	MOG490380	Urich Quarry	4/30/2022
11	MOG490703	Whistle Redi-Mix, Inc - Harrisonville	4/30/2022
12	MOG490796	Geiger Ready-Mix Company, Inc	4/30/2022
13	MOG490830	C and C Rock Quarry	4/30/2022
14	MOG491052	Materials Packaging Corporation	4/30/2022
15	MOG491094	Harrisonville Asphalt	4/30/2022
16	MOG491222	E and S Rock Quarry, LLC - Anstine	4/30/2022
17	MOG491456	Cass County Site	4/30/2022
18	MOG491465	Lehman Construction LLC Kingsville Facility	4/30/2022
MOG97 – Yard Waste Compost Sites			
19	MOG970059	Hyponex Corporation	8/6/2023
20	MOG970060	All Pro Grounds	11/29/2017
MOR## - Industrial Stormwater Runoff			
21	MOR203231	Stahl Specialty Company - Kingsville	8/31/2024
22	MOR203497	Brinkoetter's Iron Works	8/31/2024
23	MOR203523	Sioux Chief Manufacturing - Peculiar	8/31/2024
24	MOR22A345	Foster Brothers Wood Products, Inc	9/16/2024
25	MOR22B005	Hixson Lumber Sales, Pleasant Hill	8/31/2020
26	MOR22B013	UFP Harrisonville, LLC	8/31/2025
27	MOR23A106	Church and Dwight Co., Inc.	10/31/2025
28	MOR23D035	IPL USA, Inc	5/9/2022
29	MOR23D098	Tiffany Marble Inc	5/9/2022
30	MOR240624	NECO SEED FARMS INC	4/30/2019
31	MOR60A112	Busy Bee Auto Salvage and Sales, Inc.	12/11/2023
32	MOR60A375	Cook Tractor Parts, Inc.	12/11/2023
33	MOR60A409	City Scrap Metal Inc.	12/11/2023
34	MOR80C002	Sutton Trucking, Inc.	11/30/2022
35	MOR80C149	R.L. Hannah and Sons Trucking, Inc.	11/30/2022
36	MOR80C425	Durham School Services, LP CSC 3034	11/30/2022
37	MOR80C620	Lee's Summit Bin	11/30/2022

Map ID Figure 9	Permit No.	Facility	Expires
38	MOR80C646	UPRR Lee's Summit, MO Yard	11/30/2022
39	MOR80H091	Town and Country Disposal of Western MO	8/31/2024
40	MOR80H133	Roll-Off Service, LLC	8/31/2024

Permits associated with construction or land disturbance activities (MO-RA) are temporary. The number of permits of this type may vary in any given year. At the time of this report, there are 109 active construction or land disturbance permits in the South Grand River watershed (Table 14). Each permit may authorize activities on multiple sites. The MO-RA permits expire on 2/7/2022. Facilities that operate under MO-RA are required to develop and implement Storm Water Pollution Prevention Plans (SWPPP) to prevent pollutants from leaving the site. Construction and land disturbance areas are not expected to discharge stormwater that contains *E. coli* in amounts that cause or contribute to impairments in downstream water bodies.

Table 14. Construction or Land Disturbance General Stormwater Permits

Permit ID	Facility	Permit ID	Facility
MORA09311	Heritage Hills Lots 136-175	MORA13843	Prairie View of the Good Ranch
MORA09550	Creekside at Raintree	MORA13890	The Traditions
MORA09552	Raintree Pointe	MORA13909	Tall Grass, 2nd and 3rd Plat
MORA09594	LBVSD, Interceptors and Lift Station	MORA13927	Foxberry Estates
MORA09736	Water Utilities Facility	MORA14125	James A Jackson Park
MORA09878	Lake Winnebago Expansion	MORA14148	Winnebago benedict
MORA09925	Kansas City Transmission Main	MORA14393	ADS Plant
MORA10032	Woodland Trails 5th Plat	MORA14400	Gulf Express
MORA10223	Timber Trails Townhomes, 1st Plat	MORA14401	City of Belton
MORA10235	Timber Trails, 2nd Plat	MORA14456	StorageMart
MORA10249	Autumn Ridge	MORA14524	Dollar General #21327 Kingsville MO
MORA10251	Timber Trails, 1st Plat	MORA14666	Hillcrest Duplexes
MORA10341	Plastic Packaging	MORA14667	Van Hoy Office/Apartment Building
MORA10394	Quiktrip #200	MORA14731	City of Raymore
MORA10550	The Manor at Stoney Creek 2nd Plat	MORA14816	Dollar General #21278 Harrisonville MO
MORA10578	Lee's Summit Bin	MORA14823	Lakes Edge
MORA10790	Dollar General Freeman	MORA15075	Moore Residence
MORA10851	Valley Oak Angus	MORA15101	Raymore Industrial Development
MORA10857	Eagle Creek Church	MORA15105	Raymore Industrial Development
MORA10869	The Grove at Lee's Summit-Phase 1A	MORA15119	Traditions Villas
MORA10964	Arborwalk New Plats	MORA15215	Bedford Downs Second Plat
MORA11110	Church and Dwight Co., Inc.	MORA15445	FS Lee’s Summit, LLC
MORA11130	Meadowood 3rd Plat	MORA15506	Osage First Plat
MORA11224	Church and Dwight Company	MORA15522	Howerton Farms Livestock Facility
MORA11255	Brookside 8th, 9th, and 10th	MORA15546	Hickory Hills Phase 6

Permit ID	Facility	Permit ID	Facility
MORA11266	Raymore Storage Center	MORA15565	Cedarhurst of Harrisonville
MORA11271	The Residences at Echelon	MORA15592	Corbin Acres, 2nd Plat
MORA11311	Belton High School Expansion	MORA15596	Allendale Lake Meadows
MORA11387	Church and Dwight Company	MORA15756	Goppert Financial Bank
MORA11454	Lone Jack High School Improvements	MORA15984	Fox's Den Subdivision
MORA11524	Taliormade Landing	MORA16124	Harper Farm Addition
MORA11730	KDC Wireless	MORA16131	Hunter's Ridge, Lots 125-164
MORA11936	City of Raymore	MORA16296	Lee's Summit Middle School #4
MORA11992	Big D Properties	MORA16325	Brett Robinson
MORA12032	The Manor at Stoney Creek 3rd Plat	MORA16360	Woodlawn Estates 1st Plat
MORA12177	Stringtown Farm	MORA16555	Kansas City South Self Storage
MORA12291	The Grove at Lee's Summit - Mass Grading	MORA16706	Autumn Ridge
MORA12332	Hedge Hollow Race Track	MORA16758	Blue Cedar Landscape
MORA12407	Sutton Trucking	MORA16788	Arcadia
MORA12473	Traditions 2nd Plat	MORA16800	Oak Ridge Farms
MORA12568	Evan-Brook 7th Plat	MORA16802	Lee's Summit High School
MORA12643	MoKan Seed and Chemical	MORA16894	Willowind Sewer
MORA12709	Woodland Trails 6th Plat	MORA16911	Kansas City South Self Storage
MORA12751	Journey Church	MORA16923	Traditions Villas 3rd Plat
MORA12990	Pleasant Hill High School Addition	MORA16924	Traditions Villas 4th Plat
MORA12996	Lofts at Foxridge	MORA16932	LaTour Farm
MORA13011	Phillips 66 C-Store Adrian MO	MORA16960	Napa Valley 4th Plat and Detention
MORA13038	Lot 295, Newberry Landings First Plat	MORA17068	Harrisonville Aldi
MORA13053	Dogwood Gardens Event Space	MORA17179	Belton Middle School
MORA13192	Dollar General #06947	MORA17211	Woodland Trails 8th Plat
MORA13410	Stonegate Elementary School	MORA17220	Dollar General #22697 Greenwood MO
MORA13473	The Scoular Company	MORA17278	Community America Credit Union - Raymore
MORA13539	Copper Creek,3rd Plat	MORA17302	Raymore Commerce Center Lots 2 and 3
MORA13542	HT Solutions		
MORA13543	Cobey Creek,First Plat		
MORA13660	Woodland Ranch,1st Plat		

5.1.6 Illicit Straight Pipe Discharges

Illicit straight pipe discharges of domestic wastewater are potential sources of bacteria. These types of sewage discharges bypass treatment systems, such as septic tanks or sanitary sewers, and discharge directly to a stream or an adjacent land area (Brown and Pitt 2004). Illicit straight pipe discharges are illegal and are not authorized by the federal Clean Water Act or the Missouri Clean Water Law. At present, there are no data about the presence or number of illicit straight pipe discharges in the South Grand River watershed. For this reason, it is unknown to what significance straight pipe discharges contribute bacteria loads to surface waters in the watershed. Due to the illegal nature of these discharges, any illicit straight pipe discharges must be eliminated. Illicit

discharge detection and elimination is one of the six minimum control measures required by an MS4 permit.

5.2 Nonpoint Sources

Nonpoint sources are diffuse sources with no discernible, confined, or discrete conveyance, and include all categories of discharge that do not meet the definition of a point source. Nonpoint sources are not regulated by the federal Clean Water Act and are exempt from Department permit requirements by state regulation at 10 CSR 20-6.010(1)(B)1. Nonpoint source pollutants are typically transported by stormwater runoff, which is minor or negligible during dry weather conditions. Nonpoint sources include agricultural lands, onsite wastewater treatment (septic) systems, and developed areas that do not have regulated storm sewer systems. Nonpoint source pollution can also result from natural background contributions, such as wildlife waste. Streams with little to no riparian buffer are most susceptible to nonpoint source pollution.

5.2.1 Agricultural Lands

Croplands, pasturelands, and low-density animal feeding operations are potential sources of bacteria in surface waters. Bacteria are transported in runoff from areas fertilized with animal manure and where livestock are present. Runoff can result from precipitation or excessive irrigation. Soil and Water Conservation Districts provide funding and guidance for the development of nutrient management plans for unregulated private lands. Areas where nutrient management plans guide manure application, and where BMPs are used to reduce soil erosion, contribute less bacteria to surface waters than unmanaged areas. Although grazing areas are typically well vegetated, livestock tend to congregate near feeding and watering areas, which can create barren areas that are susceptible to erosion (Sutton 1990). Additionally, livestock that are not excluded from streams will deposit manure, and thus bacteria, directly into the waterway.

As noted in Section 2.4 of this document, the South Grand River watershed is dominated by cropland and pasture areas potentially used for livestock grazing. Aside from livestock present in permitted CAFOs, the exact type and number of livestock present in the South Grand River watershed are unknown. Since there are no cattle CAFOs in the watershed, the number of cattle in the South Grand River watershed can be estimated from county cattle population numbers provided in the U.S. Department of Agriculture's 2017 Census of Agriculture (NASS 2017). Using 2017 agricultural census data for Cass County, there is an average cattle density of 121 cows per square mile of pasture.[18] Based on this data, it can be estimated that there may be 74,294 cows in the South Grand River watershed.

Other types of livestock such as horses and sheep may also be contributing bacteria loads in the South Grand River watershed. The number and distribution of other animals in the watershed cannot be estimated from available data. Strategies to reduce *E. coli* loading from agricultural areas are outlined in the supplemental Implementation Strategies document located at dnr.mo.gov/water/what-were-doing/water-planning/quality-standards-impaired-waters-total-maximum-daily-loads/tmdls.

[18] This analysis assumes all areas identified as hay and pasture are being used for cattle grazing and that cattle are evenly distributed among those areas. Additionally, although some animals may be confined in some areas, for purposes of this estimation the entire cattle population was assumed to be grazing on pasture areas.

5.2.2 Runoff from Developed Areas

There are 33 municipalities in the South Grand River watershed, and as discussed in Section 5.1.4, nine municipalities hold MS4 permits that regulate urban runoff. MS4 regulated areas cover 4.8 percent of the watershed. The 24 municipalities listed in Table 15 do not have regulated MS4s, and account for approximately 1.7 percent of the watershed (21.96 square miles). Stormwater discharges from areas not regulated through MS4 permits are considered a nonpoint sources.

Table 15. Non-MS4 Municipal Areas in the South Grand River Watershed

Municipality	Area in Watershed (square miles)	Municipality	Area in Watershed (square miles)
Adrian	2.18	Gunn City	0.08
Archie	1.19	Hartwell	0.48
Baldwin Park	0.12	Holden	0.06
Blairstown	0.25	Kingsville	0.13
Chilhowee	0.22	La Tour	0.11
Cleveland	1.50	Lake Annette	0.22
Clinton	0.00	Lone Jack	1.29
Creighton	0.34	Pleasant Hill	8.19
Drexel	0.60	Riverview Estates	0.24
East Lynne	0.33	Strasburg	0.19
Freeman	0.88	Urich	0.40
Garden City	2.51	West Line	0.45

Sources of *E. coli* contaminated runoff from non-MS4 municipal areas are the same as in MS4 areas. Degradation of water quality associated with imperviousness has been shown to first occur in a watershed at about 10 percent total imperviousness and to increase in severity as imperviousness increases (Arnold and Gibbons 1996; Schueler 1994). Due to the small percentage of unregulated stormwater discharges from developed area in the watershed, runoff from these areas is not expected to contribute substantial amounts of *E. coli* to South Grand River. If the developed areas are expanded in the future, BMPs and low impact development should be considered to mitigate pollutant loading from impervious surfaces.

5.2.3 Onsite Wastewater Treatment Systems

Onsite wastewater treatment systems treat and disperse domestic wastewater on the property where it is generated. When properly designed and maintained, these systems perform well and should not contribute substantial amounts of *E. coli* to surface waters. However, when these systems fail hydraulically (surface breakouts) or hydrogeologically (inadequate soil filtration) there can be adverse effects to surface water quality (Horsley and Witten 1996). The Missouri Department of Health and Senior Services or local administrative authorities (commonly the local health department) have jurisdiction over onsite wastewater treatment systems with a design or actual flow of 3,000 gallons per day or less. Municipalities or counties may impose more stringent or additional requirements for owners of septic systems. The Missouri Department of Health and Senior Services estimates that approximately 25 percent of homes in Missouri utilize onsite wastewater treatment systems, particularly in rural areas where public sewer systems are not available (DHSS 2018). Failing onsite wastewater treatment systems can contribute *E. coli* to nearby streams under wet or dry weather conditions directly or through surface runoff and groundwater flows.

The exact number of onsite wastewater treatment systems in the South Grand River watershed is unknown. EPA's online input data server for the Spreadsheet Tool for Estimating Pollutant Load (STEPL) provides estimates of septic system numbers by 12-digit HUC watersheds based on 1992 and 1998 data from the National Environmental Service Center (USEPA 2014b).[19] These STEPL derived estimates of septic system numbers are provided in Table 16. Due to modest increases in the rural population of the watersheds since the 1990 census, this data is assumed to provide a reasonable estimate of actual septic system numbers.

Septic systems fail due to age and poor maintenance. A study by the Electric Power Research Institute (EPRI 2000) estimates septic system failure rates are 30-50 percent statewide. Due to these high failure rates, onsite wastewater treatment systems are potential sources of bacteria loading to surface waters in Missouri. However, the significance of such contributions to the South Grand River is unknown.

Table 16. STEPL Derived Estimates of Septic System Numbers

HUC 10290108-	HUC Name	No. of Systems
-0101	East Creek	1,625
-0102	Massey Creek	426
-0103	Poney Creek	300
-0104	South Fork South Grand River	88
-0105	Adams Branch-South Grand River	319
-0201	Headwaters East Branch South Grand River	869
-0202	East Branch South Grand River	927
-0203	Black Creek-South Grand River	206
-0204	Morman Fork	167
-0205	Eightmile Creek-South Grand River	238
-0301	Middle Big Creek	923
-0302	Headwaters Big Creek	443
-0303	East Branch Crawford Creek	167
-0304	West Branch Crawford Creek	122
-0305	Crawford Creek	41
-0306	Duncan Branch-Big Creek	417
-0307	Headwaters Camp Branch	162
-0308	Camp Branch	98
-0309	Lost Creek-Big Creek	63
-0401	Bear Creek	89
-0402	Panther Creek-Big Creek	208
-0403	Norris Creek-Big Creek	103
-0404	Honey Creek	57
-0405	Big Creek	58
-0501	Big Deer Creek-South Grand River	403
-0502	Sugar Creek-South Grand River	114

[19] The National Environmental Services Center is located at West Virginia University and maintains a clearinghouse for information related to, among other things, onsite wastewater treatment systems. Available URL: www.nesc.wvu.edu/

HUC 10290108-	HUC Name	No. of Systems
-0503	Elk Fork-South Grand River	75
-0504	Knob Creek	119
-0505	Cove Creek-South Grand River	47
-0506	White Oak Creek-South Grand River	207
-0701	Fields Creek-South Grand River	165
-0702	Town Creek-South Grand River	361
	Total	9,607

5.2.4 Natural Background Contributions

Wildlife such as deer, waterfowl, raccoons, rodents, and other animals contribute to the natural background concentrations of *E. coli* that may be found in a water body. Such contributions may be a component of runoff from agricultural areas, developed areas, forest lands, and other areas. While typical wildlife populations are not expected to cause or contribute to water body impairments, animals that congregate in large groups on or near water bodies may contribute significant bacteria to surface waters. For instance, Canada geese have been found to contribute significant bacteria loads in some waters (Ishii et al. 2007). There are no watershed-specific population data for Canada geese or other waterfowl, but the Missouri Department of Conservation estimated that the statewide resident Canada goose population was approximately 55,000 birds in 2016 and that the five-year average statewide duck population is 393,858 birds (MDC 2016; MDC 2020). The exact number of deer in the watershed is also not known, but the Missouri Department of Conservation keeps harvest records by county for each hunting season. Harvest data provides a general idea of the amount of deer that may be present in an area. Average yearly harvests between 2017 and 2020 in Cass County was 1,486 deer (MDC 2021). Bacteria can also be re-suspended from stream sediment because bacteria lives longer in the sediment than in water (Davis and Barr 2006; Marino and Gannon 1991). Re-suspension has been found to occur during sediment disturbance and activities such as dredging, boating in shallow areas, and swimming. The influence of any re-suspended bacteria on *E. coli* concentrations in South Grand River is unknown. Natural background contributions are included in the nonpoint source load allocations.

5.2.5 Riparian Corridor Conditions

Riparian corridor conditions have a strong influence on instream water quality. Wooded riparian buffers are a vital functional component of stream ecosystems and are instrumental in the attenuation of pollutants in runoff. Land cover within 100 feet of streams in the South Grand watershed is presented in Table 17. Agricultural areas constitute over 33 percent of the riparian corridors of streams in the watershed. These areas may be more susceptible to *E. coli* loading. Over 40 percent of the riparian corridors in the watershed are forested. This indicates that some *E. coli* transported from adjacent cropland and pasture lands into those areas may be intercepted before it enters the streams.

Table 17. Land Cover in Riparian Corridors in the South Grand River Watershed

Land Cover Type	Riparian Corridor Land Cover Type Area	
	Acres	Percent
Developed, High Intensity	0.03	0.04%
Developed, Medium Intensity	0.15	0.17%
Developed, Low Intensity	1.20	1.38%
Developed, Open Space	2.43	2.80%
Barren Land	0.07	0.09%
Cultivated Crops	8.02	9.23%
Hay and Pasture	21.25	24.46%
Forest	34.77	40.02%
Shrub and Herbaceous	0.46	0.53%
Wetlands	15.85	18.24%
Open Water	2.65	3.05%
Total:	86.89	100.00%

6. Calculating Loading Capacity

A TMDL is equal to the loading capacity of a water body for a specific pollutant, which is the maximum pollutant load that a water body can assimilate and still attain and maintain water quality standards. The loading capacity is derived from the numeric water quality criterion for each pollutant or an appropriate surrogate when no numeric criterion is applicable. Once the maximum allowable pollutant load is determined, a portion is assigned to point sources as a wasteload allocation and to nonpoint sources as a load allocation. A margin of safety is required to account for uncertainties in scientific and technical understanding of water quality in natural systems (CWA Section 303(d)(l)(C) and 40 CFR 130.7(c)(l)). The loading capacity is equal to the sum of the wasteload allocation, load allocation, and the margin of safety as follows:

$$TMDL = LC = \sum WLA + \sum LA + MOS$$

where LC is the loading capacity, ∑WLA is the sum of the wasteload allocations, ∑LA is the sum of the load allocations, and MOS is the margin of safety.

7. Total Maximum Daily Load

According to 40 CFR 130.2(i), TMDLs can be expressed in terms of mass per unit time, toxicity, or other appropriate measures. The TMDL for South Grand River is expressed as *E. coli* cfu per day using load duration curves developed using the *E. coli* criterion concentration of 206 cfu/100 mL, daily average stream flows, and a unit conversion factor.[20] Establishing TMDLs using load duration curves is consistent with the Anacostia Ruling (*Friends of the Earth, Inc., et al v. EPA*, No 05-5010, April 25, 2006) and EPA guidance in response to that ruling (USEPA 2006; USEPA 2007a).

The selected TMDL target is protective of whole body and secondary contact recreational uses. The resulting load duration curve provides a visual representation of the pollutant loading capacity of the water body at all stream flows. The TMDL is applicable during the recreational season when the

[20] $\boldsymbol{Load}\left(\frac{\text{count}}{\text{time}}\right) = \boldsymbol{Concentration}\left(\frac{\text{count}}{\text{volume}}\right) * \boldsymbol{Flow}\left(\frac{\text{volume}}{\text{time}}\right) * \boldsymbol{conversion\ factor}$

E. coli criterion applies. Using this approach the available loading capacity of the stream varies with flow, but the pollutant concentration remains constant. Although TMDLs are expressed as daily mass loads, *E. coli* criteria are expressed as geometric mean concentrations. Therefore, fluctuations in instantaneous concentrations are expected and individual bacteria measurements greater than the applicable criterion do not necessarily indicate a violation of water quality standards. Additional discussion about the methods used to develop the load duration curves for South Grand River is provided in Appendix A.

Observed data are plotted on the load duration curve graph to demonstrate the frequency of exceedance and the magnitude of load reductions that are needed to meet the TMDL and attain water quality standards. Points above the curve exceed the loading capacity and points on or below the curve are in compliance with water quality standards. The load duration curve also helps to identify and differentiate between storm-driven loading and the presence of continuous loading. Storm-driven loading is expected under wet conditions when precipitation and runoff are high. Continuous loading is evident at low flows when point source discharges have greater influence on water quality. Load reductions needed to meet the *E. coli* criterion can be estimated using the geometric means of observed data within each flow percentile range and are provided in the supplemental Implementation Strategies document located at dnr.mo.gov/water/what-were-doing/water-planning/quality-standards-impaired-waters-total-maximum-daily-loads/tmdls.

The *E. coli* load duration curve for South Grand River is displayed in Figure 10. The y-axis quantifies the *E. coli* mass load in cfu per day at the flow conditions (percentage of time flow is equaled or exceeded) on the x-axis. Lower flows are exceeded more frequently than higher flows (i.e., greater than 90 percent of the time). The flow ranges presented are consistent with EPA guidance for using load duration curves to develop TMDLs (USEPA 2007b). For this TMDL, flows greater than or equal to the 95 percent exceedance are effluent dominated at permitted design flows.

The TMDL for South Grand River and associated allocations at selected percentile flow exceedances are displayed in Table 18. Due to the extremely large numbers associated with bacteria loads, *E. coli* values are presented using scientific notation. Specific allocations for individual sources are discussed in Sections 8 and 9.

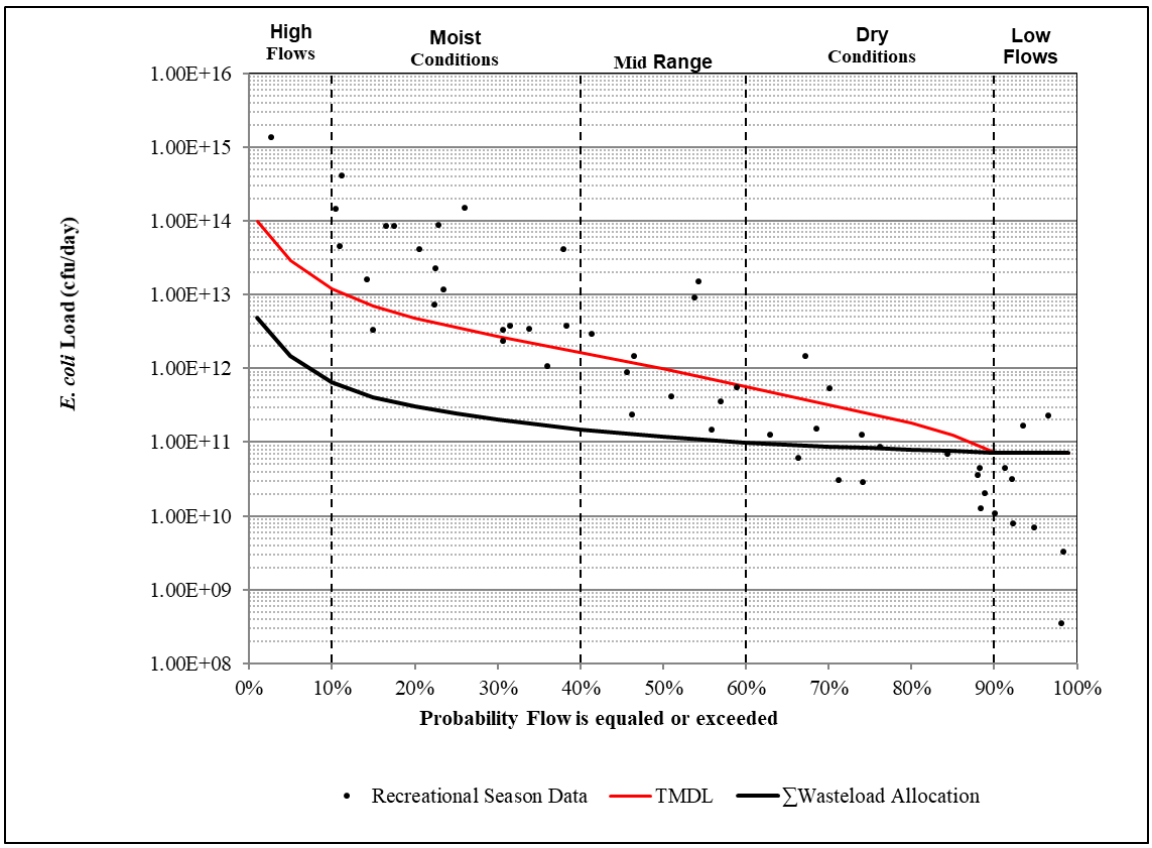

Figure 10. *E. coli* TMDL for South Grand River

Table 18. *E. coli* TMDL and Allocations for South Grand River at Selected Flows[21]

Percent of time flow is equaled or exceeded	Flow ft^3/s	LC (cfu/day)	∑WLA (cfu/day)	Missouri ∑LA (cfu/day)	Kansas ∑LA (cfu/day)	MOS* (cfu/day)
95	6.52	7.14E+10	7.14E+10	0.00E+00	0.00E+00	0.00E+00
75	47.61	2.40E+11	8.29E+10	1.30E+11	2.93E+09	2.40E+10
50	197.10	9.93E+11	1.19E+11	7.58E+11	1.70E+10	9.93E+10
25	706.07	3.56E+12	2.42E+11	2.90E+12	6.51E+10	3.56E+11
5	5,767.85	2.91E+13	1.47E+12	2.42E+13	5.43E+11	2.91E+12

* For flows ≥ 95 percent exceedance an implicit margin of safety is used.

8. Wasteload Allocation (Point Source Load)

The wasteload allocation is the portion of the loading capacity assigned to existing or future point sources. Pursuant to 40 CFR 122.44(d)(1)(vii)(B), effluent limits or other permit conditions must be consistent with the assumptions and requirements of TMDL wasteload allocations. The wasteload allocations presented in this TMDL report do not preclude the establishment of future point sources. Any future point sources should be evaluated against the TMDL, the range of flows with which any additional bacterial loading will affect, and any additional requirements associated with antidegradation. Federal regulation 40 CFR 122.4(a), disallows the issuance of an NPDES permit if

[21] The total load allocation is calculated as the remainder of the loading capacity after allocations to the total wasteload allocation and the margin of safety. Specific load allocations to Missouri and Kansas are based on the proportion of those states in the watershed. Missouri accounts for 97.8 percent of the total watershed area and Kansas accounts for 2.2 percent.

the conditions of the permit cannot provide for compliance with the applicable requirements of the federal Clean Water Act, or regulations promulgated under the federal Clean Water Act. Additionally, 40 CFR 122.4(i) states no permit may be issued to a new source or new discharger if the discharge from its construction or operation will cause or contribute to violations of water quality standards. New or expanding facilities that generate *E. coli* but disinfect wastewater prior to discharge or implement other appropriate measures to reduce *E. coli* from effluent during the recreational season (e.g., no discharge or batch discharge) consistent with applicable permit limits and conditions will result in *de minimis* bacteria loading and are not expected to cause or contribute to the impairment. Such *de minimis* loading is not expected to and must not exceed the sum of the total wasteload allocation. Decommissioning of onsite wastewater treatment systems and connecting to sewerage systems for wastewater treatment would result in net pollutant reductions that are consistent with the goals of this TMDL.

8.1 Domestic Wastewater Treatment Facilities

The aggregated wasteload allocation for domestic wastewater dischargers in the South Grand River watershed is 7.2E+10 *E. coli* cfu/day. This allocation is based on the *E. coli* criterion concentration of 206 cfu/100mL and the sum of individual facility design flows (Table 19). The wasteload allocations in this TMDL report do not authorize any facility to discharge bacteria at concentrations that exceed water quality standards. However, when effluent *E. coli* concentrations are less than 206 cfu/100mL, as is common through disinfection, the established wasteload allocation allows for increases in design flow to accommodate population increases or expansions in service area. Because disinfection systems are intended to eliminate nearly all pathogens (target = 0 cfu/100mL), rather than target a specific water quality criterion, such increases in design flow will not result in substantial increases in bacteria loading that will exceed the sum of the wasteload allocation.[22] The wasteload allocation for domestic wastewater treatment facilities is static throughout the recreational season and does not include loading that may result from sanitary sewer overflows. Sanitary sewer overflows are unpermitted discharges and are not authorized under the federal Clean Water Act. For this reason, sanitary sewer overflows in the South Grand River watershed are assigned wasteload allocations of zero at all flows.

Table 19. Wasteload Allocations for Domestic Wastewater Treatment Facilities

Permit ID	Facility	Design Flow GPD	*E. coli* WLA cfu/day
MO0028070	Harrisonville WWTF	2,400,000	1.9E+10
MO0117412	Belton WWTP	2,260,000	1.8E+10
MO0058629	LBVSD Middle Big Creek WWTP	2,250,000	1.8E+10
MO0089443	Peculiar WWTP	750,000	5.8E+09
MO0131962	Lake Lotawana CID WWTP 1	300,000	2.3E+09
MO0112623	Adrian Wastewater Lagoon	270,000	2.1E+09
MO0046647	Garden City WWTF	144,000	1.1E+09
MO0048208	Archie WWTF	130,000	1.0E+09
MO0111287	Cleveland WWTF	100,000	7.8E+08
MO0104248	Freeman WWTF	85,500	6.7E+08
MO0096091	Chilhowee WWTF	60,000	4.7E+08
MO0039764	Urich WWTF	60,000	4.7E+08
MO0025844	Kingsville WWTF	51,000	4.0E+08

[22] All antidegradation requirements associated with any proposed facility expansions remain applicable.

Permit ID	Facility	Design Flow GPD	*E. coli* WLA cfu/day
MO0099961	East Lynne WWTF	38,500	3.0E+08
MO0100102	Creighton WWTF	36,000	2.8E+08
MOGD00532	Pickering Place Inc WWTP	30,000	2.3E+08
MO0109282	Cass County Midway R-1 Schools Lagoon	24,900	1.9E+08
MO0089931	Butterbaugh Mobile Home Park WWTF	24,000	1.9E+08
MO0126179	Harrisonville South WWTP	22,500	1.8E+08
MO0107476	Sanitary Sewer District 103 WWTF	21,000	1.6E+08
MOGD00544	Oasis Mobile Home Park	20,000	1.6E+08
MO0138215	Sapp Brothers Travel Center WWTP	20,000	1.6E+08
MO0112461	Country Creek Estates WWTP	13,750	1.1E+08
MO0090697	Sherwood Cass R-VIII School WWTF	12,000	9.4E+07
MO0125351	Woodland Elementary School	12,000	9.4E+07
MO0125733	Deer Creek Lake Home Owners Association	9,999	7.8E+07
MO0107301	Slumber Inn Motel WWTF	4,999	3.9E+07
MOGD00525	MBCH-Byrne Campus WWTF	2,500	1.9E+07
MO0124150	RK Collision Repair Center WWTF	1,200	9.4E+06
MO0139181	Kornukopia Farms LLC	0	0
MO0139009	Republic Foods Facility	0	0
MOG823037	Crown Trailer Sales Inc.	0	0
MOG823169	Grab and Go	0	0
	Total	**9,157,848**	**7.1E+10**

8.2 Industrial and Commercial Facilities

Discharges from the industrial and commercial facilities in the South Grand River watershed are not expected to generate or contain *E. coli* in amounts that cause or contribute to downstream impairments. Three of the site-specific industrial permits do not allow discharge to surface waters. For these reasons, the *E. coli* wasteload allocations for all industrial and commercial facilities is set at existing permit limits and conditions. Wasteload allocations for general permitted facilities are further discussed in Section 8.5.

8.3 Concentrated Animal Feeding Operations

The CAFO facilities in the South Grand River watershed are subject to permits that do not allow discharges to waters of the state. For this reason, the *E. coli* wasteload allocations for CAFO facilities is zero at all flows. Additionally, CAFO facilities must follow permit conditions associated with land application and should not be contributors of *E. coli* loads at concentrations that cause or contribute to water body impairments.

8.4 Municipal Separate Storm Sewer Systems

Wasteload allocations for MS4 discharges are based on the proportion of the U.S. Census Bureau's defined urban area in the South Grand River watershed. Bacterial contributions from MS4 permitted entities are precipitation dependent and vary with flow. For this reason, wasteload allocated to the MS4s will also vary with flow. During extreme low flow conditions when MS4s are not discharging in response to precipitation (i.e., greater than or equal to 95 percent flow exceedance) the wasteload allocation is zero. Due to data limitations and the complex and diffuse nature of stormwater runoff, specific MS4 wasteload allocations cannot be adequately determined. For this reason, the MS4 wasteload allocations are aggregated for all MS4s. Should the U.S. Census Bureau's defined urban

area in the watershed be expanded in the future, then the appropriate portion of the load allocation may be assigned as part of the MS4 wasteload allocation if such a source's magnitude, character, and location remain unchanged. Existing MS4 permit conditions and continued implementation of BMPs and the six minimum control measures are expected to be consistent with the assumptions and requirements of the MS4 wasteload allocation. Future bacteria monitoring may provide more specific information regarding each MS4 area's actual contributions, including specific sources and mechanisms of transport, thereby allowing permit conditions to be modified accordingly. Table 20 displays the MS4 wasteload allocation at selected flows.

Table 20. MS4 Wasteload Allocations

Percent of time flow is equaled or exceeded	Flow ft^3/s	*E. coli* (cfu/day)
95	6.52	0.00E+00
75	47.61	1.15E+10
50	197.10	4.77E+10
25	706.07	1.71E+11
5	5,767.85	1.40E+12

8.5 Other General Permitted Wastewater and Stormwater Discharges

Activities that require general or stormwater permits are not typically expected to contribute *E. coli* to surface waters, and permit conditions are protective of the designated uses assigned to all water bodies in the watershed. Activities for which these permits are issued are expected to be conducted in compliance with all permit conditions, including any land application, monitoring, stormwater pollution prevention plans, and discharge limitations. For these reasons, the *E. coli* wasteload allocations for these facilities are set at existing permit limits and conditions. Future general and stormwater permitted activities that do not actively generate bacteria and that operate in full compliance with permit conditions are not expected to contribute bacteria loads above *de minimis* levels and will not result in loading that exceeds the sum of the TMDL wasteload allocations.

8.6 Illicit Straight Pipe Discharges

Illicit straight pipe discharges are illegal and are not permitted under the federal Clean Water Act. For this reason, illicit straight pipe discharges are not allocated a portion of the available loading capacity and are assigned *E. coli* wasteload allocations of zero. Any existing illicit straight pipe discharges must be eliminated and future discharges of this type should be prevented. Where stormwater is regulated by MS4 permits, the detection and elimination of illicit discharges is a required permit condition.

9. Load Allocation (Nonpoint Source Load)

The load allocation is the portion of the loading capacity assigned to existing and future nonpoint sources and natural background contributions (40 CFR 130.2(g)). For flows less than the 95 percent exceedance, the *E. coli* load allocations are equal to the loading capacity minus the wasteload allocation and the margin of safety. During low flow conditions equal to or greater than the 95 percent exceedance, significant bacterial loading from nonpoint sources is not expected and the load allocation is zero. The load allocations include contributions from agricultural lands, runoff from developed areas, and natural background contributions. No portion of the load allocation is assigned to onsite wastewater treatment systems because when they are properly maintained and operating as

designed they do not discharge *E. coli* directly to surface waters. For this TMDL, the load allocation also includes any point source and nonpoint source contributions originating from Kansas.

10. Margin of Safety

A margin of safety is required to account for uncertainties in scientific and technical understanding of water quality in natural systems (CWA Section 303(d)(l)(C) and 40 CFR 130.7(c)(l)). Based on EPA guidance, the margin of safety can be achieved through two approaches:

- Explicit - Reserve a portion of the loading capacity as a separate term in the TMDL.
- Implicit - Incorporate the margin of safety within the wasteload allocation and the load allocation calculations by making conservative assumptions in the analysis.

An explicit margin of safety equal to 10 percent of the loading capacity is included in the TMDL at flows less than the 95 percent exceedance. During low flow conditions greater than or equal to the 95 percent exceedance the stream is effluent dominated under permitted design flows. Under these conditions, disinfection systems intended to eliminate nearly all pathogens and result in *E. coli* concentrations much lower than stated permit limits will serve as an implicit margin of safety. Additionally, bacteria decay rates were not applied, and the direct recreational-season geometric mean was used for estimating the daily loading value as required by the federal Clean Water Act. This conservative assumption serves as an additional implicit margin of safety.

11. Seasonal Variation

Federal regulations at 40 CFR 130.7(c)(1) require that TMDLs take into consideration seasonal variation in applicable water quality standards. The load duration curve provides the *E. coli* loading capacity for the South Grand River at all possible flow regimes using data collected during all seasons. The *E. coli* TMDL is therefore protective of designated uses throughout the recreational season, including during critical conditions such as high flows associated with intense rainfall events when bacteria loading from nonpoint sources is more likely.

12. Monitoring Plans

The Department conducts water quality monitoring in impaired waters within a reasonable timeframe following the approval of TMDLs, completion of facility upgrades and permit compliance schedules, or the implementation of watershed BMPs. The Department will also routinely examine any available quality-assured water quality data collected by other local, state, and federal entities in order to assess the effectiveness of TMDL implementation. In addition, certain quality-assured data collected by universities, municipalities, private companies, and volunteer groups may be used to assess water quality following TMDL implementation.

13. Reasonable Assurance

Section 303(d)(1)(C) of the federal Clean Water Act requires that TMDLs be established at a level necessary to implement applicable water quality standards. As part of the TMDL process, consideration must be given to the assurances that point and nonpoint source allocations will be achieved and water quality standards attained. Where TMDLs are developed for waters impaired by point sources only, reasonable assurance is provided through the National Pollutant Discharge Elimination System (NPDES) permitting program. State operating permits requiring effluent and instream monitoring be reported to the Department provide reasonable assurance that instream water quality standards will be met.

Where a TMDL is developed for waters impaired by both point and nonpoint sources, point source wasteload allocations must be stringent enough so that in conjunction with the water body's other loadings (i.e., nonpoint sources) water quality standards are met. Reasonable assurance that nonpoint sources will meet their allocated amount is dependent upon the availability and implementation of nonpoint source pollutant reduction plans, controls, or BMPs within the watershed. If BMPs or other nonpoint source pollution controls allow for more stringent load allocations, then wasteload allocations can be less stringent. Thus, the TMDL process provides for nonpoint source control tradeoffs (40 CFR 130.2(i)). When a demonstration of nonpoint source reasonable assurance is developed for an impaired water body, additional pollutant allocations for point sources may be allowed provided water quality standards are still attained. If a demonstration of nonpoint source reasonable assurance does not exist, or it is determined that nonpoint source pollutant reduction plans, controls, or BMPs are not feasible, durable, or will not result in the required load reductions, then allocation of greater pollutant loading to point sources cannot occur.

A variety of grants and loans may be available to assist watershed stakeholders with developing and implementing watershed based plans, controls, and practices to meet the required wasteload and load allocations in the TMDL and demonstrate reasonable assurance. Information regarding potential funding sources, cost-share opportunities, and implementation actions that address nonpoint source loading in the South Grand River watershed are provided in the supplemental TMDL Implementation Strategies document available online at dnr.mo.gov/water/what-were-doing/water-planning/quality-standards-impaired-waters-total-maximum-daily-loads/tmdls.

14. Public Participation

EPA regulations at 40 CFR 130.7 require that TMDLs be subject to public review. A 45-day public notice period for this TMDL report is scheduled from October 8 through November 22, 2021. Groups that directly received notice of the public comment period for this TMDL include, but are not limited to:

- South Grand River Watershed Alliance
- Missouri Clean Water Commission;
- Missouri Department of Conservation;
- Mid-America Regional Council;
- Kaysinger Basin Regional Planning Commission;
- Cass and Henry County Soil and Water Conservation Districts;
- Kansas Department of Health and Environment
- County health departments;
- County commissions;
- University of Missouri Extension;
- Missouri Coalition for the Environment;
- Stream Teams United;
- Stream Team volunteers living in or near the watershed; and
- Missouri state legislators representing areas within the watershed.

In addition to those groups directly contacted about the public notice, this TMDL report and an implementation strategies document are posted on the Department's TMDL webpage dnr.mo.gov/water/what-were-doing/water-planning/quality-standards-impaired-waters-total-

maximum-daily-loads/tmdls. All comments received during this period and the Department's responses to those comments are also available at this location.

The Department maintains an email distribution list for notifying subscribers of significant TMDL updates or activities, including public notices and comment periods. Those interested in subscribing to TMDL updates can submit their email address using the online form available at public.govdelivery.com/accounts/MODNR/subscriber/new?topic_id=MODNR_177.

15. Administrative Record and Supporting Documentation

The Department has an administrative record on file for the South Grand River *E. coli* TMDL. The record contains plans, studies, and other information on which the TMDL is based. It additionally includes the TMDL implementation strategies document, the public notice announcement, any public comments received, and the Department's responses to those comments. This information is available upon request to the Department at dnr.mo.gov/open-records-sunshine-law-requests. The Department will process any request for information about this TMDL in accordance with Missouri's Sunshine Law (Chapter 610, RSMO) and the Department's administrative policies and procedures governing Sunshine Law requests.

16. References

Arnold, C.L. and C.J. Gibbons. 1996. Impervious surface coverage: the emergence of a key environmental indicator. Journal of the American Planning Association 62.2

Brown, E., Caraco, D. and R. Pitt. 2004. Illicit Discharge Detection and Elimination a Guidance Manual for Program Development and Technical Assessments. EPA X-82907801-0

Burton, A.G. Jr. and R.E. Pitt. 2002. Stormwater effects handbook, a toolbox for watershed managers, scientists, and engineers. ISBN 0-87371-924-7 New York:CRC Press.

Chapman, S.S., Omernik, J.M., Griffith, G.E., Schroeder, W.A., Nigh, T.A., and Wilton, T.F. 2002. Ecoregions of Iowa and Missouri (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,800,000).

Davis, J. V., & Barr, M. N. (2006). *Assessment of Possible Sources of Microbiological Contamination in the Water Column and Streambed Sediment of the Jacks Fork, Ozark National Scenic Riverways, Missouri--phase III*. US Geological Survey.

Dewitz, J., 2019. National Land Cover Database (NLCD) 2016 Products: U.S. Geological Survey data release. https://doi.org/10.5066/P96HHBIE. Available URL: https://www.mrlc.gov/viewer/ [Accessed November 2020].

DHSS (Missouri Department of Health and Senior Services). 2018. Onsite Wastewater Treatment webpage. [Online WWW] Available URL: health.mo.gov/living/environment/onsite/ [Accessed 15 October 2019].

EPRI (Electric Power Research Institute). 2000. Advanced On-Site Wastewater Treatment and Management Market Study: Volume 2.

Federal Geographic Data Committee (FGDC). 2003. FGDC Proposal, Version 1.1, Federal Standards for Delineation of Hydrologic Unit Boundaries. December 23, 2003.

Horsley & Witten, Inc. 1996. Identification and Evaluation of Nutrient and Bacterial Loadings to Maquoit Bay, Brunswick, and Freeport, Maine.

Ishii, S., Hansen D., Hicks, R. and Sadowsky, M. 2007. Beach Sand and Sediments are Temporal Sinks and Sources of *Escherichia coli* in Lake Superior. Environ Sci Technol 41, 2203 – 2209.

Lodish H, Berk A, Zipursky SL, et al. 2000. Molecular Cell Biology, 4th Edition, Section 6.16. New York: W. H. Freeman. [Online WWW] Available URL: https://www.ncbi.nlm.nih.gov/books/NBK21593/

Marino, R. P., & Gannon, J. J. (1991). Survival of fecal coliforms and fecal streptococci in storm drain sediment. *Water research*, *25*(9), 1089-1098.

MDC (Missouri Department of Conservation). 2016. Waterfowl Hunting Digest 2014 – 2015.

MDC (Missouri Department of Conservation). 2021. Deer Harvest Summaries. [Online WWW] Available URL: https://huntfish.mdc.mo.gov/hunting-trapping/species/deer/deer-harvest-reports/deer-harvest-summaries [Accessed 11 June 2021].

MoRAP (Missouri Resource Assessment Partnership). 2005. A gap analysis for riverine ecosystems of Missouri. Final report, submitted to the USGS national gap analysis program. 1675pp.

NASS (National Agricultural Statistics Service) USDA. 2017 NASS Online Agricultural Statistics Data. [Online WWW] Available URL: https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_2_County_Level/Missouri/ [Accessed 11 June 2021].

NOAA (National Oceanic and Atmospheric Administration). 2020. NOAA National Centers for Environmental Information, Data Tools 1991-2020 Normals. [Online WWW] Available URL: https://www.ncei.noaa.gov/access/us-climate-normals/#dataset=normals-monthly&timeframe=30&station=USW00053879 [Accessed June 2021].

NRCS (Natural Resources Conservation Service). 2009. National Engineering Handbook, Part 630 Hydrology, Chapter 7 Hydrologic Soil Groups.

NRCS (Natural Resources Conservation Service). 2020. Soil Survey Geographic Database (SSURGO) for Missouri. [Computer file].

Rogers, Shane and John Haines. 2005. Detecting and Mitigating the Environmental Impact of Fecal Pathogens Originating from Confined Animal Feeding Operations: Review. EPA/600/R-06/021.

Schueler, Tom. 1994. The importance of imperviousness. Watershed Protection Techniques. 1.3

Sutton, Alan L. 1990. Animal Agriculture's Effect on Water Quality Pastures and Feedlots. WQ-7. Purdue University Extension. [Online WWW]. Available URL:

http://www.ces.purdue.edu/extmedia/wq/wq-7.htmL [Accessed 23 Dec. 2011].

U.S. Census Bureau (U.S. Department of Commerce). 2010. TIGER/Line Shapefile, 2010, 2010 state, Missouri, 2010 Census Block State-based [ArcView Shapefile].

USDA (U.S. Department of Agriculture). 1995. Animal Manure Management – RCA Issue Brief #7. [Online WWW] Available URL: nrcs.usda.gov/wps/portal/nrcs/detail/null/?cid=nrcs143_014211 [Accessed 15 May 2018].

USEPA (U.S. Environmental Protection Agency). 1983. Results of the Nationwide Urban Runoff Program – Executive Summary PB84-185545.

USEPA (U.S. Environmental Protection Agency). 1986. Design Manual – Municipal Wastewater Disinfection. EPA/625/1-86/021

USEPA (U.S. Environmental Protection Agency). 1996. Sanitary Sewer Overflows – What are they and how can we reduce them? EPA 832-K-96-001

USEPA (U.S. Environmental Protection Agency). 2006. Establishing TMDL "daily" loads in light of the decision by the U.S. Court of Appeals for the D.C. Circuit in Friends of the Earth, Inc. v. EPA, et al., No. 05-5015, (April 25, 2006), and implications for NPDES Permits. [Online WWW] Available URL: www.epa.gov/tmdl/impaired-waters-and-tmdls-tmdl-information-and-support-documents [Accessed 15 May 2018].

USEPA (U.S. Environmental Protection Agency). 2007a. Options for Expressing Daily Loads in TMDLs. Office of Wetlands, Oceans & Watersheds. June 22, 2007.

USEPA (U.S. Environmental Protection Agency). 2007b. An Approach for Using Load Duration Curves in the Development of TMDLs. EPA 841-B-07-006.

USEPA (U.S. Environmental Protection Agency). 2014a. Environmental Justice? [Online WWW] Available URL: www.epa.gov/environmentaljustice [Accessed 16 May 2018].

USEPA (U.S. Environmental Protection Agency). 2014b. STEPL Data Server for Sample Input Data. [Online WWW] Available URL: it.tetratech-ffx.com/steplweb/STEPLdataviewer.htm [Accessed 16 May 2018].

USGS (U.S. Geological Survey). 2009. Ecology-Ecological Drainage Units. [Online WWW] Available URL: nh.water.usgs.gov/projects/ct_atlas/tnc_edu.htm [Accessed 7 June 2017].

USGS (U.S. Geological Survey). 2019. Hydrologic Unit Maps. [Online WWW] Available URL: https://water.usgs.gov/GIS/huc.html [Accessed 2019].

Weaver, R.W., J.A. Entry, and Alexandria Graves. 2005. Numbers of Fecal Streptococci and Escherichia coli in Fresh and Dry Cattle, Horse, and Sheep manure. Canadian Journal of Microbiology. Vol.51, No. 10: pp 847-851

Appendix A

Development of the *E. coli* Load Duration Curve

Overview

A load duration curve was used to develop the *E. coli* TMDL for South Grand River. Load duration curves visually display the loading capacity of a water body at all possible flows based on historical flow data and the defined target concentration for the pollutant. For this TMDL, a portion of the *E. coli* loading capacity is assigned as a static wasteload allocation based on the individual design flows of domestic wastewater treatment facilities present in the watershed. A flow variable wasteload allocation is assigned to MS4 permitted entities based on the proportion of urban area present in the watershed. During extreme low flow conditions when MS4s are not discharging in response to precipitation (i.e., greater than or equal to 95 percent flow exceedance) the wasteload allocation is zero. For flows less than the 95 percent exceedance 10 percent of the loading capacity is reserved as an explicit margin of safety. An implicit margin of safety is used for flows greater than or equal to the 95 percent flow exceedance when the stream is effluent-dominated. The remaining portion of the loading capacity after allocations to point sources and the margin of safety is allocated to nonpoint sources.

Methodology

Load duration curves are based on flow duration curves developed using a long-term time series of daily flows and a numeric water quality target. Average daily flow data that are representative of the impaired segment are used to develop the flow duration curve. If sufficient flow records for the impaired stream segment are not available, then flow data collected from a gage or gages in a representative watershed may be used, or a flow duration curve can be derived by synthesizing long-term flow data from several gages within the same ecological drainage unit.

For the South Grand River, a flow duration curve for the impaired segment was derived using flow data from two gages in the watershed, USGS 06921600 South Grand River at Urich, MO and USGS 6921720 Big Creek near Blairstown, MO. The combined flows from these gages were area corrected to the watershed area of WBID 1249. The period of flow from June 1, 2007 to June 28, 2021 was used. Flows for gage 06921600 prior to July 24, 2014 were estimated using a regression analysis based on measured flows from USGS gage 06921590 South Grand River at Archie, MO.

The numeric target for *E. coli* in South Grand River is the whole body contact category B criterion of 206 cfu/100 mL. The *E. coli* TMDL was calculated using the target concentration of 206 cfu/100 mL, average daily flows, and a conversion factor of 24,465,715 in order to generate the loading capacity in units of cfu/day.[23] Despite the varying load, the target concentration is constant at all flow percentiles and reflects the static nature of the water quality standards. The observed data provided in Appendix B are plotted on the load duration curve graphs in Section 7 to demonstrate the magnitude of load reductions that are needed to meet the TMDL and attain water quality standards.

[23] $Load\ \left(\frac{\text{count}}{\text{day}}\right) = \left[Target\left(\frac{\text{count}}{\text{100ml}}\right)\right] * \left[Flow\ \left(\frac{feet^3}{s}\right)\right] * [Conversion\ Factor]$

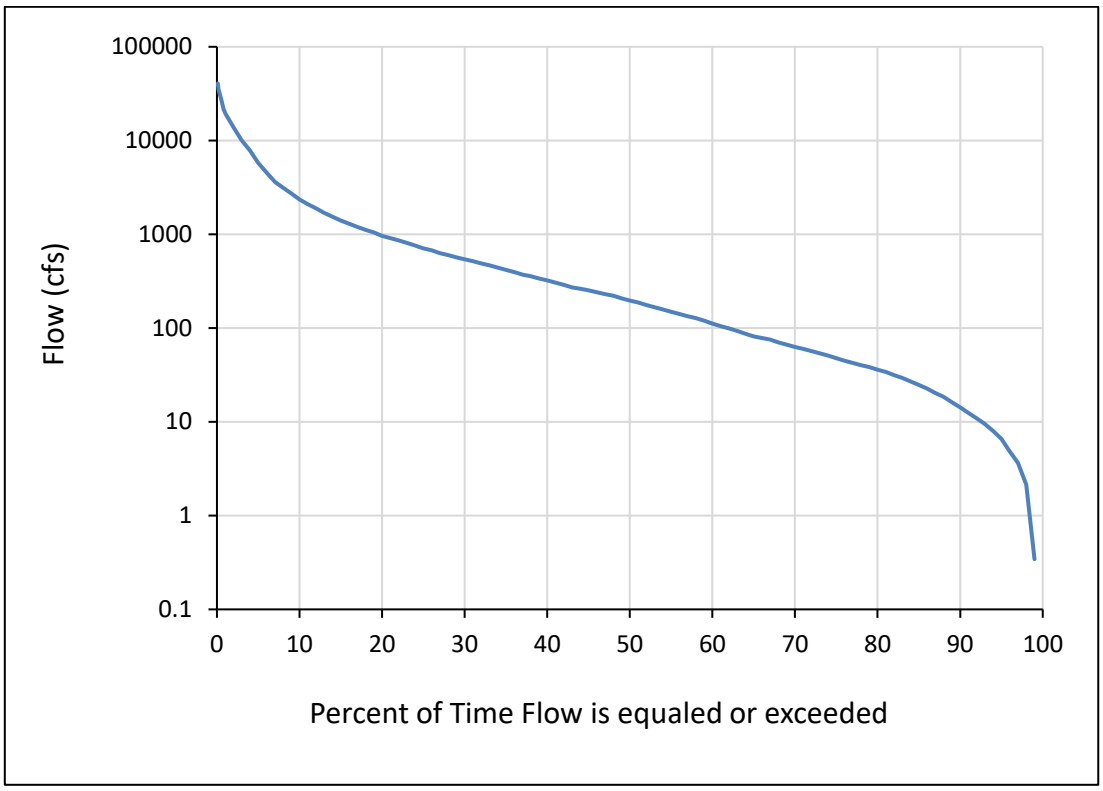

Figure A-1. South Grand River Flow Duration Curve

Appendix B

South Grand River (WBID 1249) Recreational Season *E. coli* data collected by the U.S. Geological Survey (USGS)

Date	Site Code	Site Name	Sample ID	Rec Season?	Ecoli (#/100ml)
4/17/2007	1249/49.4	S. Grand R.@ 293rd St.	16702	Y	470
5/4/2007	1249/49.4	S. Grand R.@ 293rd St.	16703	Y	15,000
6/14/2007	1249/43.2	S. Grand R. nr. Archie	16596	Y	43
7/13/2007	1249/43.2	S. Grand R. nr. Archie	16597	Y	90
9/13/2007	1249/43.2	S. Grand R. nr. Archie	16598	Y	100
5/14/2008	1249/43.2	S. Grand R. nr. Archie	16602	Y	3,000
7/23/2008	1249/43.2	S. Grand R. nr. Archie	16603	Y	23
9/11/2008	1249/43.2	S. Grand R. nr. Archie	16604	Y	100
5/19/2009	1249/43.2	S. Grand R. nr. Archie	197371	Y	310
7/8/2009	1249/43.2	S. Grand R. nr. Archie	197372	Y	92
9/23/2009	1249/43.2	S. Grand R. nr. Archie	197373	Y	4,000
10/27/2009	1249/43.2	S. Grand R. nr. Archie	197374	Y	2,600
5/27/2010	1249/43.2	S. Grand R. nr. Archie	197377	Y	8,200
7/22/2010	1249/43.2	S. Grand R. nr. Archie	197378	Y	1,800
9/8/2010	1249/43.2	S. Grand R. nr. Archie	197379	Y	80
10/28/2010	1249/43.2	S. Grand R. nr. Archie	197380	Y	32
5/10/2011	1249/43.2	S. Grand R. nr. Archie	211118	Y	180
7/29/2011	1249/43.2	S. Grand R. nr. Archie	211119	Y	41
9/20/2011	1249/43.2	S. Grand R. nr. Archie	211120	Y	120
10/26/2011	1249/43.2	S. Grand R. nr. Archie	211121	Y	82
5/14/2012	1249/43.2	S. Grand R. nr. Archie	222442	Y	110
9/14/2012	1249/49.4	S. Grand R.@ 293rd St.	237215	Y	770
9/25/2012	1249/43.2	S. Grand R. nr. Archie	231518	Y	7
10/23/2012	1249/43.2	S. Grand R. nr. Archie	237206	Y	2,200
5/17/2013	1249/43.2	S. Grand R. nr. Archie	237209	Y	40
7/23/2013	1249/43.2	S. Grand R. nr. Archie	237210	Y	29
9/3/2013	1249/43.2	S. Grand R. nr. Archie	237211	Y	150
10/30/2013	1249/43.2	S. Grand R. nr. Archie	237212	Y	55
5/16/2014	1249/43.2	S. Grand R. nr. Archie	243593	Y	190
7/28/2014	1249/43.2	S. Grand R. nr. Archie	243594	Y	49
9/19/2014	1249/43.2	S. Grand R. nr. Archie	250457	Y	2,300
10/31/2014	1249/43.2	S. Grand R. nr. Archie	250458	Y	32
5/18/2015	1249/43.2	S. Grand R. nr. Archie	254705	Y	4,700
7/20/2015	1249/43.2	S. Grand R. nr. Archie	254709	Y	440
9/24/2015	1249/43.2	S. Grand R. nr. Archie	254711	Y	800
10/19/2015	1249/43.2	S. Grand R. nr. Archie	254713	Y	40
5/10/2016	1249/43.2	S. Grand R. nr. Archie	277493	Y	2,800
7/15/2016	1249/43.2	S. Grand R. nr. Archie	277494	Y	1,100
9/26/2016	1249/43.2	S. Grand R. nr. Archie	277495	Y	4,700
10/11/2016	1249/43.2	S. Grand R. nr. Archie	277496	Y	400
5/22/2017	1249/43.2	S. Grand R. nr. Archie	275192	Y	350
7/7/2017	1249/43.2	S. Grand R. nr. Archie	275193	Y	310
9/15/2017	1249/43.2	S. Grand R. nr. Archie	275194	Y	21

Date	Site Code	Site Name	Sample ID	Rec Season?	Ecoli (#/100ml)
10/13/2017	1249/43.2	S. Grand R. nr. Archie	275195	Y	150
5/21/2018	1249/43.2	S. Grand R. nr. Archie	276487	Y	4,400
7/20/2018	1249/43.2	S. Grand R. nr. Archie	276488	Y	880
9/14/2018	1249/43.2	S. Grand R. nr. Archie	276489	Y	80
10/12/2018	1249/43.2	S. Grand R. nr. Archie	276490	Y	430
4/22/2019	1249/43.2	S. Grand R. nr. Archie	300550	Y	110
5/16/2019	1249/43.2	S. Grand R. nr. Archie	300551	Y	96
8/1/2019	1249/43.2	S. Grand R. nr. Archie	300552	Y	250
9/26/2019	1249/43.2	S. Grand R. nr. Archie	300553	Y	260
10/30/2019	1249/43.2	S. Grand R. nr. Archie	300554	Y	9,100
7/9/2020	1249/43.2	S. Grand R. nr. Archie	301632	Y	350
8/11/2020	1249/43.2	S. Grand R. nr. Archie	301633	Y	600
9/22/2020	1249/43.2	S. Grand R. nr. Archie	301634	Y	110
10/8/2020	1249/43.2	S. Grand R. nr. Archie	301635	Y	31